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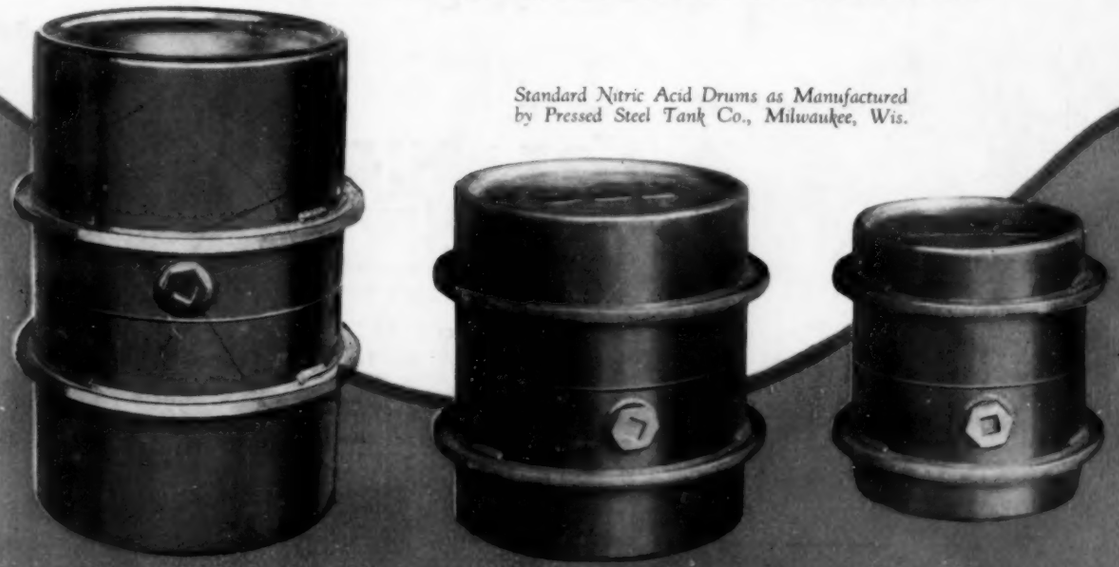

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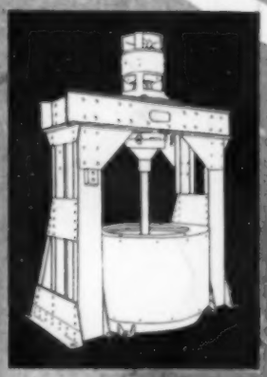

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CHEMICAL & METALLURGICAL ENGINEERING

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To Europe for Chem. & Met.

H. C. PARMELEE, Editor of *Chem. & Met.*, sailed for Europe on S. S. "Cedric" on April 7. Before returning to this country in June he expects to visit some of the principal chemical centers of England, Germany, France and Norway.

To our foreign friends he carries a personal greeting from this magazine and the industries it serves. Many whom he sees, particularly in England, will be the guests of the American Institute of Chemical Engineers when the Institution of Chemical Engineers meets in the United States next August.

To all of our readers Mr. Parmelee's trip will give, through the pages of *Chem. & Met.*, a more intimate understanding of chemical engineering and industrial developments abroad. The first of Mr. Parmelee's articles, cabled from England, will appear in the May issue of *Chem. & Met.*

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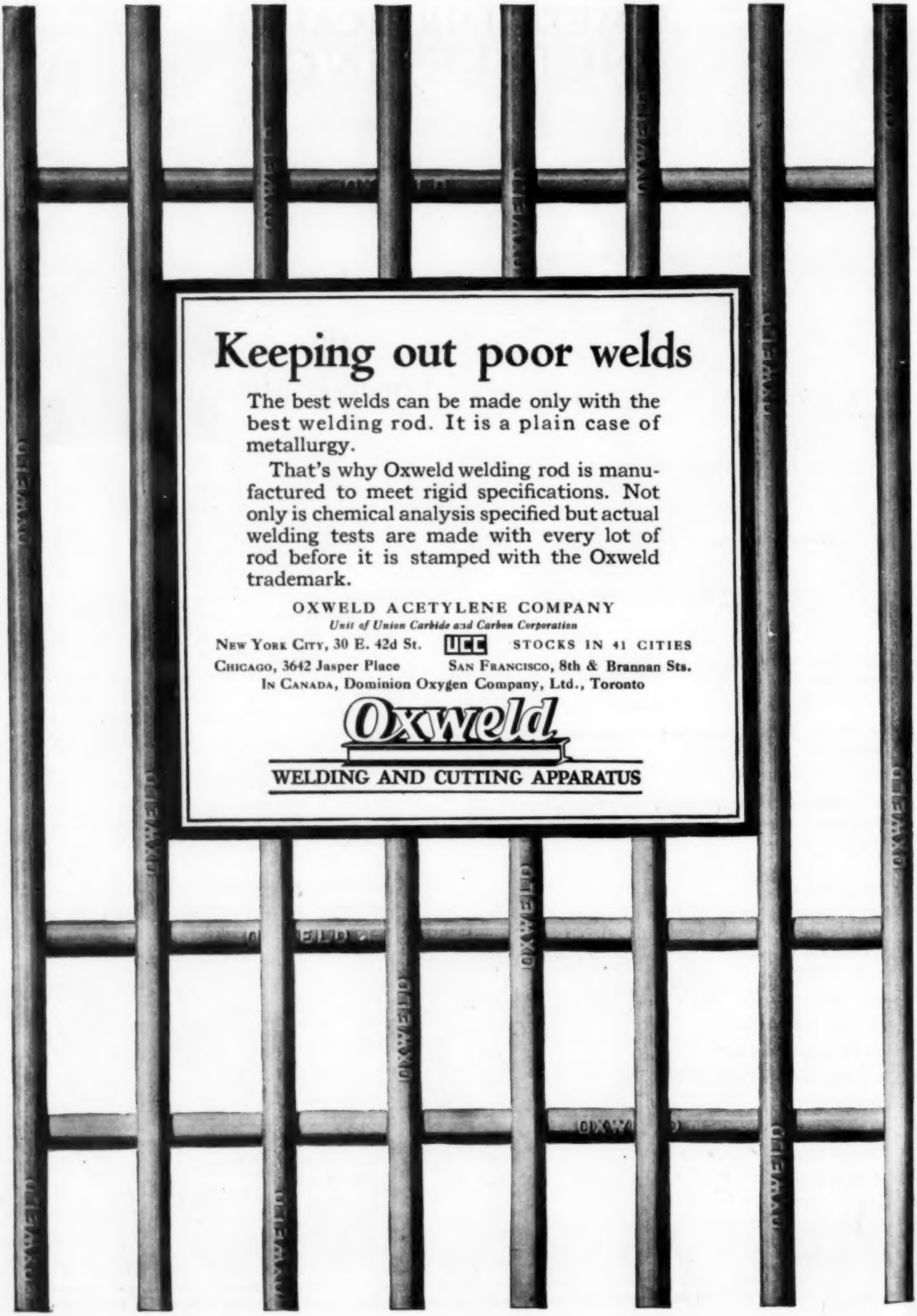

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CHEMICAL & METALLURGICAL ENGINEERING

H. C. PARMELEE
Editor

Volume 35 — New York, April, 1928 — Number 4

Engineering Statesmanship and the Presidency

ACTIVE participation in national politics is a comparatively recent rôle for the engineer, yet it is one that is becoming increasingly important. We have reached a critical stage in our national development. The growing complexity of our industrial structure and the consequent readjustment and realignment of economic forces in agriculture and commerce have emphasized the need for a different viewpoint from that of the professional politician. There is an unusual opportunity for the practical application of engineering and scientific principles in the administration of the public affairs of the nation. The mind of the engineer, trained by experience to study facts and anticipate their consequences, holds the most promising solution for many of our national problems.

THE distinguished recipient of the Saunders Medal of the A.I.M.E. recently said: "The job of the engineer is the application of science to the increased comfort of man—to take from the laboratory of the scientist the raw material of thought and discovery and to materialize it into daily use." He has pointed further to the fact that "engineers have come into a wider responsibility than solely in the application of their technology—more and more the engineers are becoming the administrators of great industry. To them come more and more the human problems of relations between employer and employee, the relations between producer and consumer. The mind trained to regard the consequences of action in their human results bids fair to be the largest of the contributions of the engineering profession." These remarks serve to explain the medalist's own remarkable contribution to government and society. They reveal an engineering ideal which Herbert Hoover, perhaps more than any other of the profession, has been able to translate into actual attainment.

ADMINISTRATION of the Department of Commerce under Secretary Hoover bears apt testimony to the effectiveness of the engineering mind in the solution of national problems. Such economic studies as the elimination of waste in industry, the control of the business cycle, or the building up of an adequate statistical service to industry have been practical demonstrations of the engineering method. First the problem is stated, then all of the facts are ascertained usually by arousing and directing the collective thinking of those of experience and judgment in such affairs. Next the plan is formulated, its conclusions tested, and finally a program is evolved that offers a logical and workable solution to the problem in hand. This kind of thinking has been responsible for the efficient manner in which have been discharged the ever-broadening responsibilities that have fallen to the lot of the Secretary of Commerce.

CHEM. & MET. is not concerned with partisan politics except as they affect the chemical engineering industries. We have, however, the sincere belief that the continued advance of all industry will depend upon wise leadership in government. A new kind of statesmanship is needed that will combine the vision of the economist with the practical achievement of the engineer. Herbert Hoover—more than any other individual in public life—offers just that unusual combination of the engineering mind with a broad grasp of the fundamental economics of both industry and government.

Clearing the Decks For Tariff Action

ALL DOUBT as to the constitutionality of the so-called flexible provisions of the tariff law, was finally removed on April 9, by the unanimous decision of the United States Supreme Court, handed down by Chief Justice Taft in the case of the J. W. Hampton, Jr., and Company, vs. The United States. For almost five years this litigation over the collection of an added duty on barium dioxide has had the attention of the courts. As a test case, it assumed importance quite out of proportion to the minor value of the imported commodity, but it became doubly significant when appealed on the additional score that under the powers given it by the Constitution, Congress could not legislate solely for the protection of domestic manufacturers. Fortunately for American industry, the constitutionality of both the flexible and protective provisions have now been upheld by our highest tribunal.

In support of the principle underlying the flexible tariff, Chief Justice Taft cited the rate-making powers that have been delegated to the Interstate Commerce Commission. Likewise, he declared, "if it is thought wise to vary customs duties according to changing conditions of production at home and abroad, it (Congress) may authorize the chief executive to carry out this purpose with the advisory assistance of a tariff commission appointed under Congressional Authority." In upholding the constitutional right of Congress to levy a protective tariff, the Chief Justice called attention to the first tariff act of July 4, 1789, which was drawn by many of the same founders of our government who had framed the constitution itself. One of the purposes this first tariff law contained in its opening paragraph was the "encouragement and protection of manufactures." Chief Justice Taft concludes his decision with the view—"whatsoever we may think of the wisdom of a protective policy, we cannot hold it unconstitutional."

From the immediate viewpoint of the American manufacturer, and importer as well, it is to be hoped that this decision may have an accelerating effect on the Tariff Commission's adminstration of the flexible tariff provision. At a time when a general tariff revision is out of the question, this provision offers the only avenue of relief. With its constitutionality definitely established, there is no valid reason for further delay in putting the operation of the flexible tariff on a prompt and business-like basis.

Newsprint Meets the Overproduction Bogey

CANADA and the United States produced over 3,500,000 tons of newsprint in 1927, an output considerably below capacity. Moreover, the productive capacity is expanding largely, particularly in Canada where new and projected mills are expected to raise the potential annual output of the Dominion to 3,000,000 tons before the end of this year—150 per cent of its 1927 production. While part of this increased capacity will undoubtedly be counterbalanced by further curtailment in American mills, permanent equilibrium will be established only when the consumption curve resumes the steep upward trend so rudely interrupted last year.

Meanwhile, the situation presents elements of interest to other industries: The substantial faith of the newsprint makers in the future of their business; the common sense and co-operative spirit which is leading the industry safely through a critical period; and the fact that the technical man with his research, his doctrine of simplified and standardized practice and his devices for the reduction of labor and waste has become a key man in the scramble for lower costs. Instead of deluding themselves with full production schedules, maintained at profit-consuming sales effort, the mills have been content with that share of the business which their performance was able to win for them. True, the adjustment has been facilitated by the extensive consolidations of newsprint interests which have been consummated in recent months, but this trend is itself a testimonial to co-operative effort, standardized practice and faith in the basic stability of the industry. Finally, the added dependence placed upon the technical men in time of stress is in pleasant contrast to the not so distant past when first aid to flagging profits in certain industries prescribed the amputation of such luxuries.

That this confidence is not misplaced is testified by the numerous striking economies and improvements in newsprint production effected by technical men during the past year. After all, while the road to creative achievement may look broader and more inspiring to the chemical engineer in times of milk and honey, his advancing footsteps echo sturdily and cheerily between the drab, narrow profit margins of bread and butter alley.

Dollars, Fishes and Faucets

LIKE the old man of the sea, trade wastes have ridden the back of the chemical industry from its obscure beginnings to its place today in the front lines of industrial endeavor. In some cases, the old man has been effectively disciplined and converted into a valuable servant. Wastes have become marketable byproducts through further treatment and the creation of new demands. Occasionally, the spectacular has happened and the former waste has displaced the parent product as the principal *raison d'être*. When uses for supposedly unmarketable byproducts have been sought, the trouble has usually been worth the while.

Where the old man still rides the industrial back, however, continual effort must be made to unseat him. It is only natural that paths of least resistance be followed. When a convenient stream can remove waste effluents without apparent fuss, muss or bother and without mental effort or capital investment, well and good, provided that embryo dollars are not flowing from the drain pipe, provided that the streams are not being rendered unfit thereby for aquatic life and human consumption. These provisos are seldom all fulfilled.

When there are no possible or apparent uses for waste materials, proper disposal is often onerous. It is obvious that the degree and nature of stream pollution determines the extent of the nuisance. If communities become sufficiently incensed over trespass of their common law right to water unflavored with synthetic tastes, legislatures may be relied upon to set legal, though not necessarily logical, limits upon permissible waste concentration. It is better to anticipate an aggrieved public than to risk its ill will and the passage of more or less ruinous legislation.

One solution of an elusive waste disposal problem has been described on page 215 of this issue of *Chem. & Met.* Byproduct coke oven plants have their old men of the sea

in the form of calcium phenolate wastes from the ammonia lime stills. The phenolate, when run into the streams, produces free phenol, which in turn, upon subsequent chlorination in water filtration plants, yields chlorophenol in minute but unappetizing proportions. The problem's ultimate solution is one that may easily be applied.

Tinkering Again With the Patent Law

AGAIN the friends of the World War veterans are trying to take advantage of pre-election conditions to secure legislation that is unsound economically, in fact of no value to most veterans and of doubtful value to any but the very few. The latest proposal takes the form of a bill in Congress to extend the life of patents which are held by war veterans. The proposed legislation contemplates increasing the life of such patents by not more than three times the period during which the patentee served in the armed forces of the United States.

Even the advocates of these bills admit that very few individuals would profit from them. Any impartial observer must realize that the proposal is a blow at sound basic patent law. If enacted such measures would throw in doubt every existing patent to the extent of making it difficult to know when any patent expired without a special search of the patent records. Such tinkering with basic patent practice is highly undesirable.

If there be those individual veterans who by war service have been prevented from the prompt development of their patent rights they can be properly cared for by individual relief bills. It will do no harm to provide for correction of any injustice that may exist in that fashion. But it is wholly unnecessary, in order to provide for the few cases of alleged injustice, that industry should suffer a break-down of the basic patent structure, which normally provides a definite patent life of seventeen years.

Politics vs. Good Sense

AS ONE of our friends often says, "It's hard to reason like a Congressman." To do so demands a greater appreciation for politics, which means votes, than for the sound principles of economics and the technical requirements of industry. The action of the House of Representatives in defeating by a substantial majority the Newton bill is another demonstration that that body still acts primarily on political motives and does not, on many occasions, determine its actions on the basis of the general public welfare.

The Newton bill proposed to legalize pool buying of commodities, such as rubber, which are controlled by producing monopolies. It promised a means for American industry to defeat those unwarranted and unreasonable monopolies which undertake to create artificial price levels by production control, either with or without foreign government co-operation. The bill originated in the conception advanced by the Secretary of Commerce of pool buying to meet pool selling. It, therefore, bore the earmarks of Herbert Hoover. It was defeated primarily as an anti-Hoover action, and not at all because the members of Congress opposed the idea in principle.

Congressman Newton, of Minnesota, who drafted this bill, did so upon his own initiative after a thorough study of the question and with full personal knowledge of the international significance of monopolies. It happens that Congressman Newton has expressed himself politically as a supporter of Mr. Hoover. It is known, however, that he did not write the bill at Mr. Hoover's request and that he had not consulted the Secretary of Commerce regarding either the political or the economic significance of the bill. Nevertheless, the bill was earmarked by Mr. Hoover's political opponents as one by which to discredit him and his friends. The result was inevitable—a coalition of anti-Hooverites with the Democrats easily defeated the measure.

Politics may be ruthless and selfish in the extreme, but there are limits to which even politics may go.

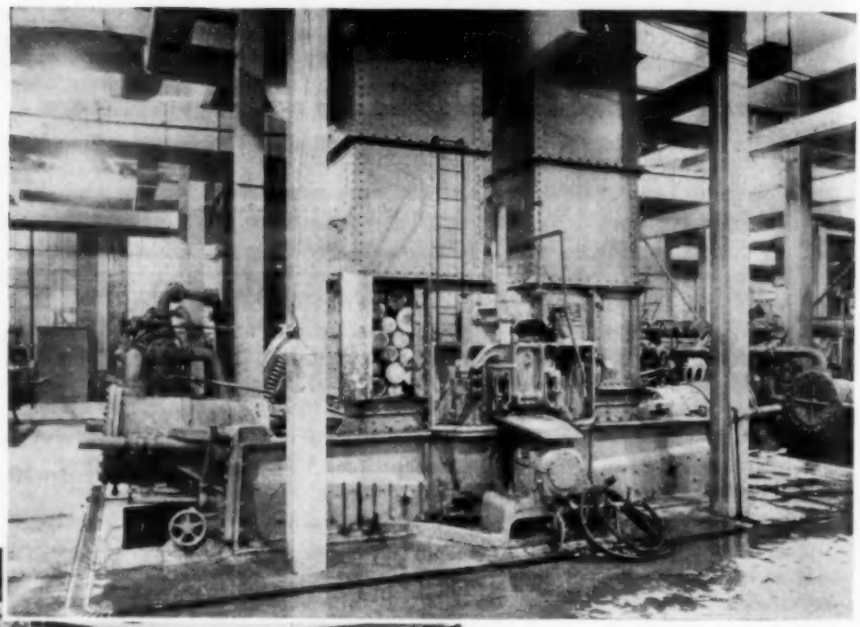
A Preparedness Program For Industrialists

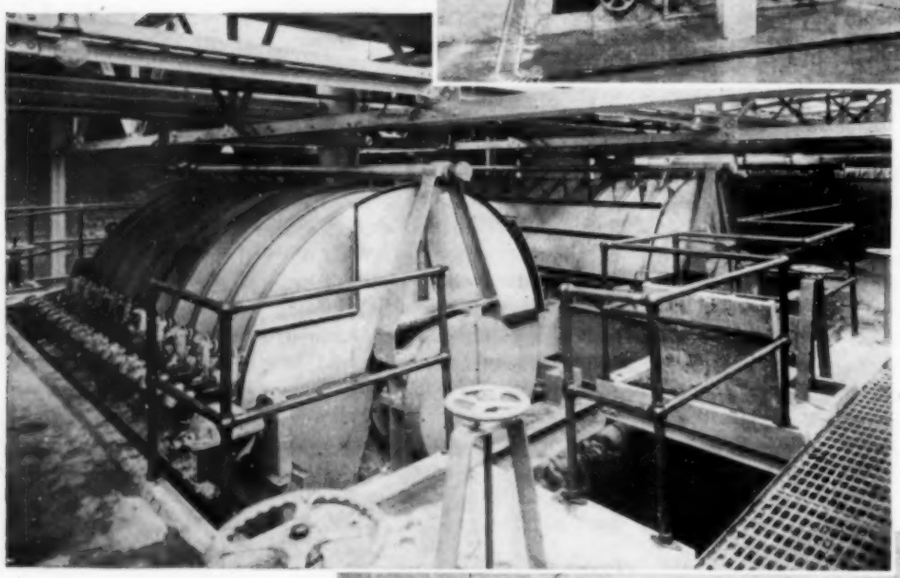
WASHINGTON is said to have remarked that "In time of peace, preparedness is one of the most effective ways of preventing war." While there are those who will dispute the statement, public sentiment is quite generally in agreement. In one phase of such preparedness, however, the National Defense Act of 1920 is not in accord. The act provides, in effect, that military supplies in times of peace must be produced by government-owned or controlled agencies where possible and when outside sources cannot fill the needs more economically. It is recognized, however, that in war times, such agencies cannot hope to meet the demand for military armament and supplies. In times of emergency, national safety depends upon the ability of the country's industries to assume quickly the burden of such manufactures.

Preservation of the arts of manufacture involved, however, on the part of the industries demands fairly continuous experience in the manufacture of military supplies. In pursuance of this realization, the last session of Congress was asked to amend the defense act to permit the setting aside of the feature of the act which forces private industry to compete with the Government, when and in the opinion of the Secretary of War, private manufacture of military supplies is desirable from an educational standpoint. The amendment provides further that such allotment of contracts be made at the discretion of the Secretary without reference to competitive bids, but rather, where the experience to be gained will do the greatest educational good.

The amendment was not enacted into law. Secretary of War Davis has again brought the bill to the attention of the present Congress. Manufacturers who appreciate the desirability of such enactment fear, however, that their views, if strongly expressed, may be interpreted as occasioned by their own self-interest. Although this interpretation will undoubtedly be made in certain demagogic circles, squeamishness and timidity must be put aside. It is not alone the arms and machinery manufacturers, who must assist in attracting favorable congressional consideration for the bill. In future wars the chemical industry may well play a part of greater importance than any other producing group. True, the nature of the industry is such that it must perforce keep in step with nearly all chemical developments. This does not, however, detract from the value of the specialized type of experience that is available in the handling of military requirements. Chemical industry must do its share in impressing the facts upon the Senate.

In the Quebec Mill of the Anglo Canadian Pulp and Paper Mills, Ltd.

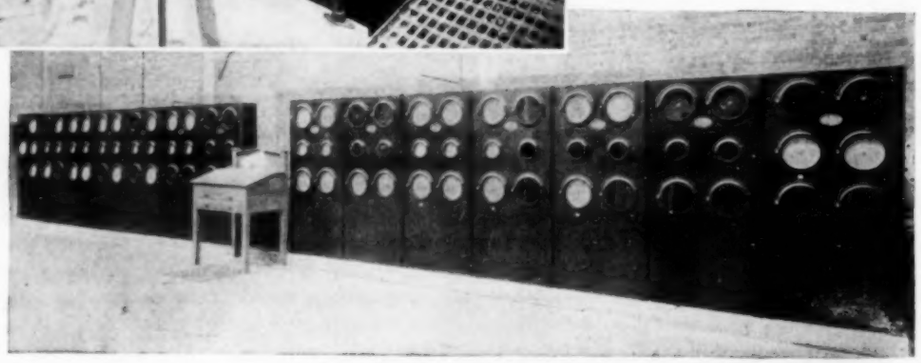




Above—Waterous pulp grinder with magazine door open to show logs. Note ventilating ducts near ceiling

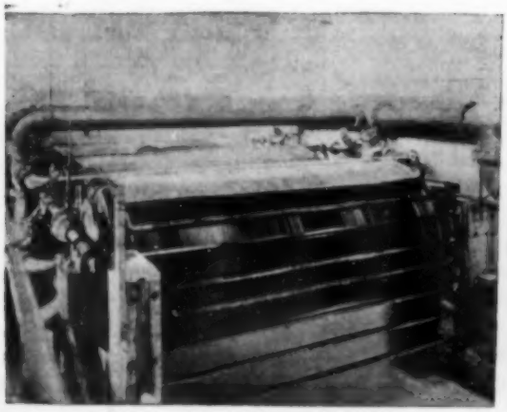
Left—American filters "deckering" ground-wood, sulphite and reclaimed pulp. The thickened pulp drops to the stock chests below

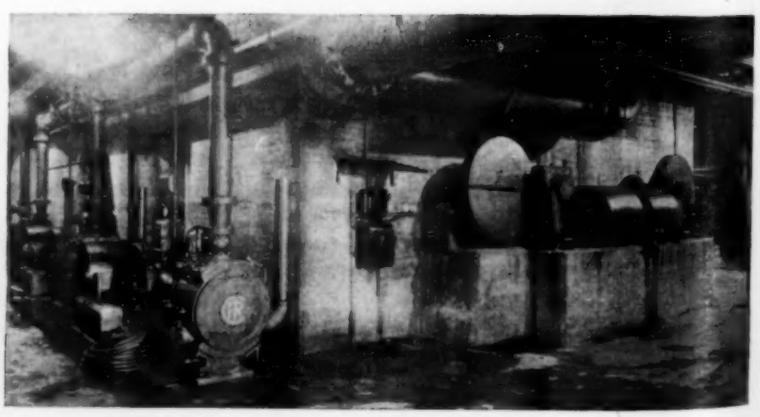
Below—Control panel in mixing department where operating conditions throughout the mill are recorded



Below (left)—Bull screens filtering ground-wood pulp

Below (right)—Concrete stock chest below mixing room showing agitator drive





Efficient Arrangement Characterizes This Modern Newsprint Mill

Plant of the Anglo Canadian Pulp and Paper Company at Quebec a model of design for low production cost and high quality paper

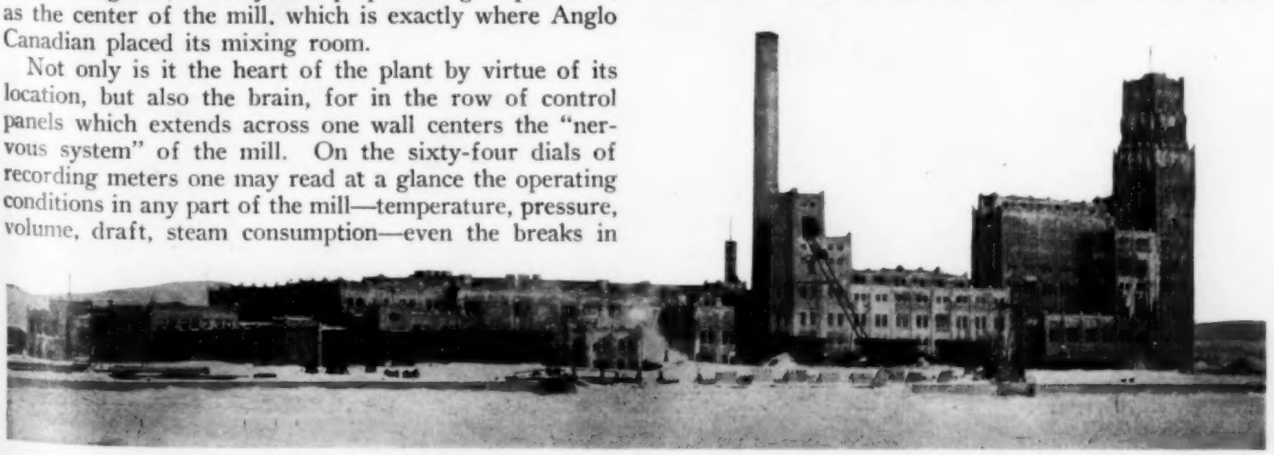
By A. E. Buchanan, Jr.
Assistant Editor of Chem. & Met.

WITHIN the limits of picturesque Quebec, at the junction of the St. Charles and St. Lawrence Rivers, stands the newly built newsprint mill of the Anglo Canadian Pulp and Paper Mills Limited. Not only is the plant unique among paper mills but it is of general interest to chemical engineers because of its logical, spacious arrangement, its complete flexibility and the application of recording instruments, labor saving and safety devices to the limit of ingenuity. As an appropriate crowning triumph, this splendid mill is housed in a structure architecturally worthy of its location on the bank of the "mighty St. Lawrence." Of the 96½ acres comprising the site, 88 acres were reclaimed from tidal flats by filling with sand pumped from the river bottom, leaving 30 ft. of water at low tide off the 1,350-ft. concrete wharf and giving facilities for shipment by boat to all parts of the world.

In the newsprint mill, the paper machine is supplied with a pulp suspension consisting of ground wood mixed with chemically-pulped wood, or sulphite pulp, the proportion of the two varying according to the grade of paper desired, and other factors, but always with the cheaper ground-wood pulp predominating, in the ratio of approximately 3 to 1. Thus, the newsprint mill may be imagined as a letter Y, with the vertical leg representing the paper machine, into which converge the two arms, representing the ground-wood pulp and the sulphite pulp departments. This elementary analogy is recorded to emphasize the logic of considering the point of convergence, namely the pulp mixing department, as the center of the mill, which is exactly where Anglo Canadian placed its mixing room.

Not only is it the heart of the plant by virtue of its location, but also the brain, for in the row of control panels which extends across one wall centers the "nervous system" of the mill. On the sixty-four dials of recording meters one may read at a glance the operating conditions in any part of the mill—temperature, pressure, volume, draft, steam consumption—even the breaks in the paper on the 4 machines are registered on an ingenious 4-pen instrument. The total steam consumption throughout the plant and its distribution are recorded by flow meters with integrators; electric level gages show and record the flow of stock over tanks and weirs; pyrometers on the sulphur burners and draft gages on the gas fan report instantaneously from the sulphite mill. Thus perfect co-ordination of operations in the steam plant, the ground-wood mill, the sulphite mill and the machine room is possible.

TURNING from the control panel, one views the mixing room, which is dominated by the bank of nine American filters, especially designed for pulp "deckering." Each filter consists of ten disks, covered with 60-mesh copper screen (old fourdrinier wire) and runs at 15 to 17 inches vacuum. It is estimated that 98 per cent reclamation is obtained by this equipment, with about 175 gallons of pulp suspension handled per hour per square foot of screen area. The "white water" filtrate is pumped to various parts of the mill for use in washing or thinning the stock, while the pulp is peeled off the screens by rotating rubber scrapers and dropped to the stock chests in the basement. Beside the filters are the Bird centrifugal screens which receive pulp from the ground-wood and sulphite mills, screen it and throw it up to the filter chests. At each end of the mixing room is a Trimbey mixer, which automatically controls the amounts of the different pulps which are blended before delivery to the mixed pulp chest and thence to



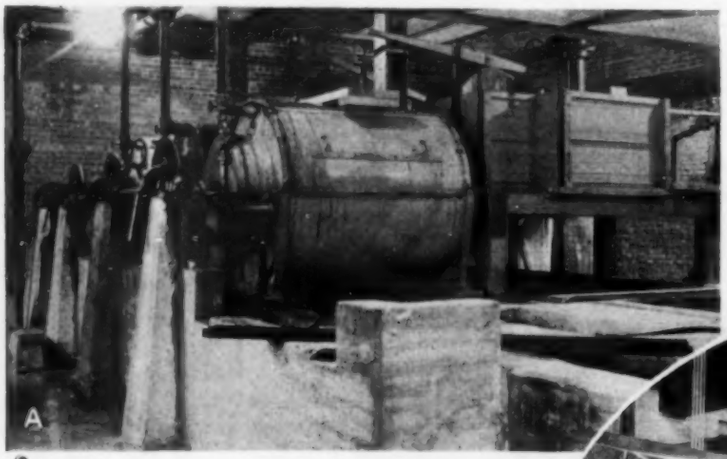
the paper machines. All the stock chests in the basement are provided with agitators consisting of two longitudinal shafts, with paddle arms rotating at 8 to 10 r.p.m., preventing settling of the stock.

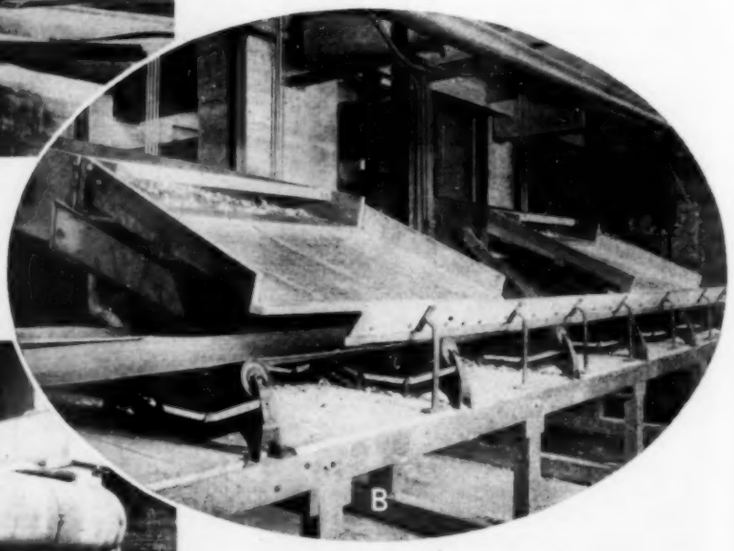
The course of the wood through the two pulping processes will now be traced from the wood pile to the mixing room. Logs are floated from the Company's timber lands, down the Montmorency River to within a few miles of Quebec, whence they are delivered in 4-ft. lengths by rail, and stacked at the eastern end of the mill site. Blocks are conveyed into the washing drum building and tumbled through the rotating cylinder at the rate of 30 cords per hour. This drum, constructed by William Hamilton, Ltd., is 12 ft. in diameter, 45 ft. long, built of heavy channel irons and set in a concrete pit on roller bearings. Washed by heavy streams of water as they tumble, the blocks emerge at the low end on to a cable and button conveyor which carries them over the bridge to the transverse conveyors, two of which lead into the two lines of block bins above the grinders and a third to the sulphite mill.

The bottoms of the block bins extend the length of the charging floor, directly above the grinder room. On either side of each of the two bins is a line of charging doors in the floor, opening to the grinder magazines.

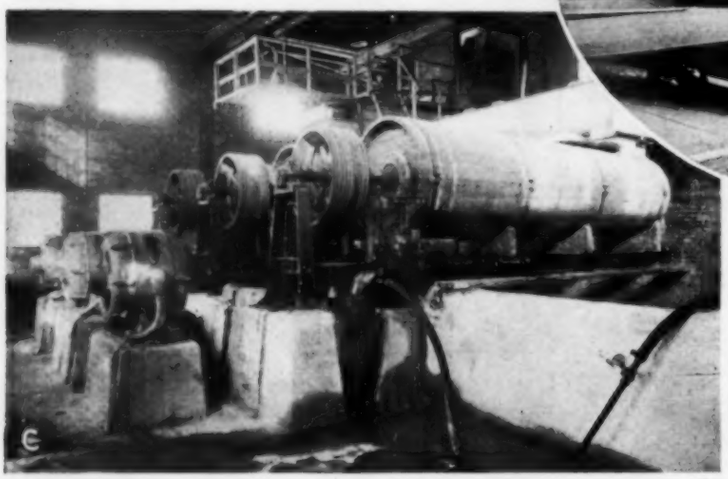
Two double rows of Waterous pulp grinders occupy this room. Each pair of grinders is driven by a 2,600-hp. motor located between them; the two grinders with motor constituting a "line." There are six such "lines" in one row and four in the other, or twenty stones in all, with space for four more lines when needed. The grinders are of the hydraulic magazine type, in which the blocks are fed to the stone under hydraulic pressure, the stone being cooled by water sprays. When the chamber is empty, the plunger automatically draws back, allowing a charge of blocks to tumble down from the magazine into the grinding chamber. An ingenious electrical load regulator controls the hydraulic pressure on the wood so that the power consumption of the grinder motors is maintained constant. A "buzz-saw" disc, penetrating the side of the magazine is rotated by the blocks as they fall through the magazine and registers the consumption of pulp wood—about 20 tons per day per grinder.

UNDER the grinders run troughs to conduct the pulp to the bull screens which are simply perforated cylinders, rotating rapidly and flushed by a heavy stream of white water, allowing the pulp to pass into a concrete pit, but rejecting the unground slivers. The bull screen pit is drained by centrifugal pumps which elevate the pulp to the Bird screens in the mixing room, thence through the American filters and down to the mechanical pulp chest. Wood for chemical pulp enters the mill over the same bridge, but drops to a transverse conveyor leading to the sulphite mill. The logs are discharged into two 110-in. Waterous chippers each of which chews up from 10 to 15 cords per hour and discharges the chips to 2 double screens, the upper mesh retaining the oversize, the lower retaining good chips and passing the sawdust. An interesting feature of these screens is the





Views in the Anglo Canadian Sulphite Mill



A—Knotters, removing uncooked knots from pulp

B—Chip screens and chip conveyor. Note unique screen suspension

C—Pulp separators, receiving pulp from blow pits and discharging to knotters

D (Next page)—Wet end of Anglo Canadian's No. 1 paper machine

method of suspension, consisting of six bundles of six wooden rods, their natural resiliency permitting the violent shaking motion which is, of course, applied at the high end by a motor and eccentric. The oversize chips fall to a belt conveyor and travel to a chip crusher whence they are returned to the screens. The good chips ride a belt conveyor to a bucket elevator, are raised to the top of the chip bins, over which they travel on another belt conveyor and are distributed to the bins.

Directly below the chip bins is the charging floor for the digesters. A hopper rolls on rails under the bin outlets for introducing the charge (about 25 cords). The digestors, built by the Horton Steel Works, Ltd., are 16 ft. in diameter and 54 ft. high, and lined with a 7-in. acid resistant brick lining. There is an instrument panel for each of the four digestors on which the temperature, pressure and steam consumption are recorded.

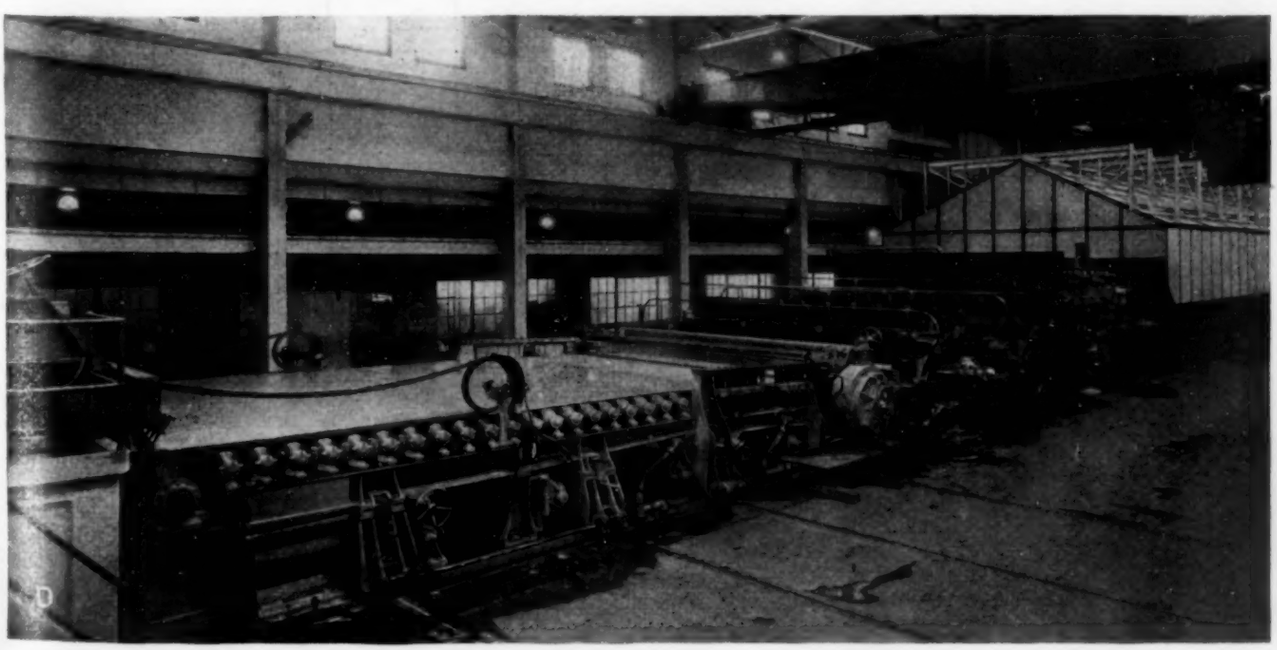
The acid plant supplying cooking acid for the digestors is somewhat different in design from that of the average mill, an elaborate attempt having been made to conserve the heat and SO_2 content of the liquor and vapors blown off through the pressure relief lines during the cook. To this end, two vertical cylindrical steel tanks, known as accumulators are provided, into which the blown-off liquor and vapor is conducted, to impart its SO_2 and heat to the acid therein. Raw acid from the acid storage tanks is pumped into the accumulators where it picks up the heat, absorbs SO_2 and builds up its "combined" acid strength. Using this preheated liquor for the next charge obviously saves steam and time.

ANOTHER novel item in the acid plant design is the location of the sulphur burners, which instead of being on the ground floor are on the same level as the digestor charging floor. There are two burners, of the usual rotary type, with preheating pans straddling them. Sulphur is dumped from the floor above, into these pans where it melts, and is fed molten to the burners. The sulphur charging floor is on the level of the tops of the two concrete acid towers. A freight elevator runs between the towers to this level and brings up the buggies of sulphur and limestone, the former to be dropped to the burners and the latter into the acid towers. Locating the burners thus, near the tops of the towers, necessitates drawing the hot gas down through the coolers, on the floor below and down to the tower inlet where the fan is located, but it has the advantage of placing the burner room in close proximity to the digestor charging floor, so that the same operator can supervise each and co-ordinate the two operations.

Jennsen coolers of the usual type, consisting of a series of vertical *U* pipes constructed of heavy lead, and cooled by running water, stand in a shallow concrete tank. The gas is discharged into the towers near the bottom by the fan, beside which are the acid pumps. Raw acid from the towers is run first to the concrete settling tank and thence to the acid storage tanks.

INSTEAD of the usual practice of "blowing" the digestors after the cook, this mill prefers to shut off the steam and drain the digestors into the blow pits with very little steam pressure. It is believed that a stronger, better pulp is obtained thus than when the contents of the digestor are blown out at high pressure. However, it involves handling equipment of a character entirely different from that of the usual sulphite mill, and this feature of the plant is perhaps the most interesting to the chemical pulp manufacturer. There are six blow pits, in the form of adjacent rectangular concrete tanks, the sides lined with southern pine, a false bottom of perforated wood and a tile bottom. At the end of a cook, the pulp is run into the blow pits at about 15 lb. steam pressure, the sulphite liquor being allowed to drain off through the perforated false bottom to the sewer. Water sprays are so located around the pits that a heavy stream can be turned on the pulp to wash it and to be then drained off. This washing is so effective that the odor of sulphite is hardly detectable in a sample of the pulp as it leaves the pits.

After the chemical pulp has been sufficiently washed and drained, it is removed from the blow-pits by means of the "pulp diggers," an ingenious automatic digger and conveyor designed and made in Sweden. The machine runs on rails which enable it to travel over every section of the six pits. It starts at one end of one pit by lowering a bucket conveyor which scoops up pulp



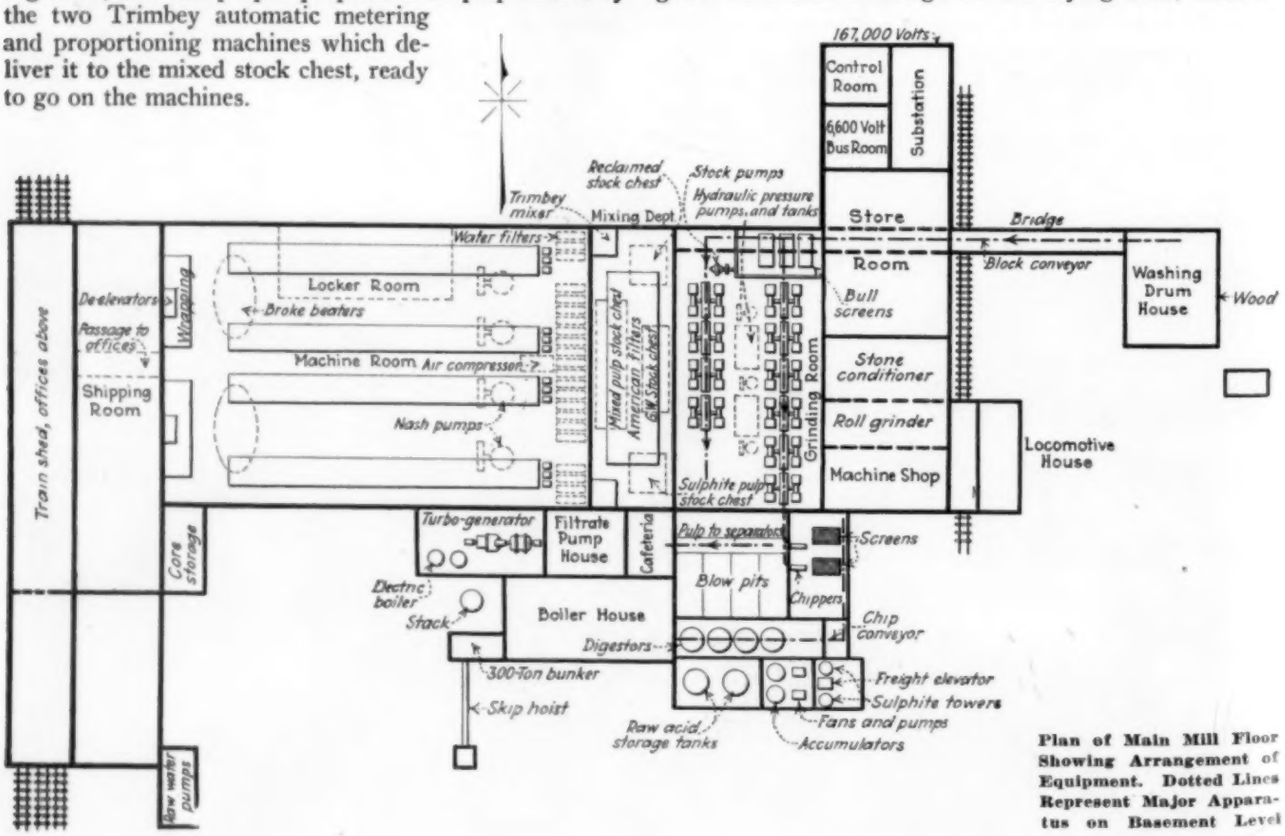
from the center of the pit. Attached to either side of the conveyor frame is a spiral screw, extending to the two edges of the pit to scrape the pulp in from the sides to the bucket conveyor. The latter discharges it to a belt conveyor running across one end of the blow pits and up to the top of the mill for further treatment. The pulp digger travels slowly and automatically back and forth over the length of each blow pit.

Discharged at the top of the belt conveyor, the sulphite pulp drops into a screw conveyor and is fed to the Swedish pulp separators where it is disintegrated by the rotating fingers and flushed out into a concrete flume. Flowing by gravity to the next level, it passes through the knotters, which screen out any uncooked knots, and thence flows down to the mixing room to pass the Bird screens, American filters and collect in the stock chest.

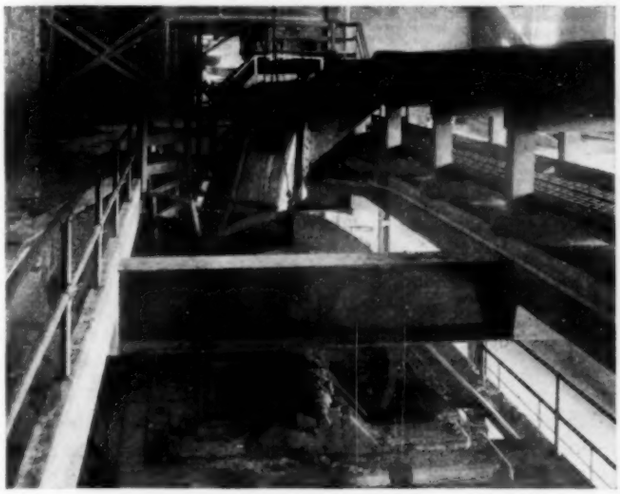
PRODUCTION of mechanical and chemical pulp has been traced from the log pile to the respective storage chests in the basement below the mixing department. Here there is also a third concrete tank, the reclaimed pulp chest into which all the stray pulp and "broke," from the paper machines finds its way. Any imperfect rolls of newsprint, the torn paper resulting from breaks on the machine, and the trim from the slitters and rewinder is dropped through the floor of the machine room down to two mammoth beaters in the basement, where it is wet down and re-pulped, to be pumped back to a jordan for further refinement and thence to the reclaimed pulp chest. One of the interesting features of the plant from the material-handling standpoint, is the galvanized iron ducts which lead from the winders down to the beaters and through which the trim is hustled, as fast as it comes from the machine, by an air current.

Pulp in the stock chests is thinned to desired consistency by the automatic action of a Trimbey consistency regulator, and the proper proportion of pulp mixed by the two Trimbey automatic metering and proportioning machines which deliver it to the mixed stock chest, ready to go on the machines.

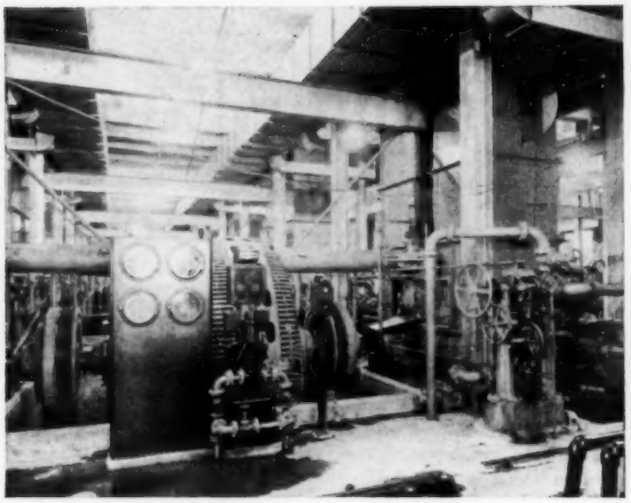
FOUR machines, each making a sheet 234 in. wide at speeds up to 1,400 ft. per minute, are housed in the machine room, which measures 360 by 180 ft. Three Bird screens beside each machine give the pulp a final screening to remove any of the long "slivers" which might cause breaks on the machine if they happened to come at the edge of the sheet. These screens are equipped with vanes so that they also serve as centrifugal pumps, throwing the pulp up to the pond or reservoir where it is thinned down by carefully adjusted water sprays and fed through a specially designed outlet 234 in. wide, on to the endless belt of 60-mesh fourdrinier wire. This particular type of outlet is known as the Van de Carr slice, its merit being its effectiveness in preventing turbulence of the pulp as it flows on the screen. In its travel on the wire the pulp forms into a sheet, drains, partially by gravity and further by the vacuum applied through the screen as it passes over the "flat boxes." The sheet is now sufficiently formed to permit of its transfer to felt endless belts to be carried through the press rolls and driers. The forty-six steam-heated drying rolls, 60 in. in diameter, are driven by electric motors mechanically synchronized by an ingenious device known as the Harland drive, which automatically adjusts rheostats in the field circuits of the driving motors to compensate for slight variations in the speed from a set standard. This interlocking regulator provides accurate synchronization of different parts of the machine and thus prevents breaking of the paper due to uneven tension. The drying rolls are heated on the countercurrent princple, the dry steam entering the rolls at the dry end of the machine and passing back to the wet end. Condensate from the drying rolls is drained to a receiver which automatically discharges when full, measuring and recording the amount of condensate and incidentally, recording each break on the machine. An endless rope guide runs over the edge of the drying rolls, used to



Plan of Main Mill Floor Showing Arrangement of Equipment. Dotted Lines Represent Major Apparatus on Basement Level



One of the 110-Inch Waterous Chippers in the Sulphite Mill, Showing Block Conveyor Which Feeds It



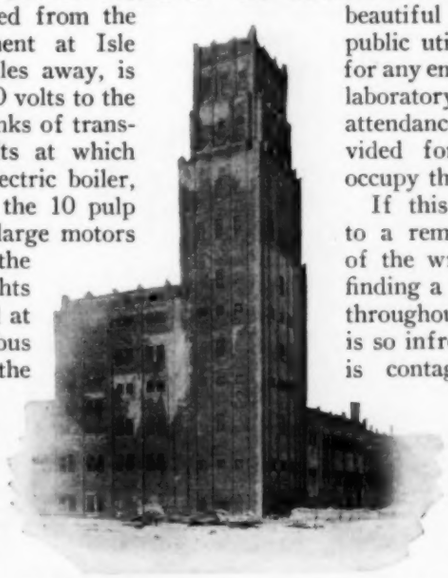
View in Grinder Room Showing One of the 2,600 Hp. Motors. Automatic Load Regulator in Foreground

carry the paper through the system when starting the machine or after a break. Steam supplied to the drying rolls is metered on recording, integrating flow meters. Tachometers record the paper speed at the dry end, electric level indicators show the level of pulp in the pond and recording gages, the vacuum on the wire.

Finished rolls are lifted by crane to the winders, and wrapped on a heavy paper core at a speed as high as 3,000 ft. per minute. Immediately behind the winders, on low platforms, is the finishing department. Idler roll conveyors in this platform serve for handling the finished rolls. The heavy paper wrapping is put around the roll, the ends folded over, smeared with silicate glue, and rolled between steam heated head-presses which press on the end sheets.

The wrapped paper rolls back to the platform of a de-elevator and is lowered to the shipping room on the basement level, immediately adjoining the shipping room.

AT PRESENT, the daily production of the Anglo Canadian mill is about 250 tons of newsprint, with the machines running seven to eight hundred feet per minute. When the fourth paper machine goes into production and the speed is increased, the production should be 500 tons per day. Power, purchased from the Duke-Price hydro-electric development at Isle Maligne, on Lake St. John, 140 miles away, is delivered over a double line at 167,000 volts to the Anglo-Canadian substation. Two banks of transformers step it down to 6,600 volts at which potential it is used in a 6,000 hp. electric boiler, located in the steam plant, and for the 10 pulp grinder motors. Incidentally, these large motors are started by remote control from the substation panels, safety signal lights being installed both on the board and at the motors. From the 6,600-volt bus bar, 12 other transformers step the current down to 2,200 and 550 volts for the 450 motors throughout the mill. About 36,000 hp. will be used in normal operation. In addition to the purchased power, a 10,000-hp. Westinghouse turbo-generator is provided, driven by the 400-lb. steam pressure from the boiler plant. Steam for the drying rolls is bled off from the turbine. The generator is connected so as to pick up the load of the paper machines and other vital operations automatically in case of an interruption of the purchased power. The steam plant consists of three B. & W. 1,250-hp. boilers with Taylor stokers and hydraulic ash removers. The coal is carried up outside the building by a skip hoist which discharges to an overhead bunker of 300 tons capacity, whence it is distributed to the boilers by a lorry, equipped with automatic weighing and recording device.



The Anglo Canadian Tower, Housing Water Tank and Sulphite Towers

PAGES might be written describing the auxiliary and service departments of this mill. Walking back from the shipping room, one passes through a commodious locker room, equipped with showers and every convenience for workers. Under the wet end of the machine room are the Nash pumps which operate the flat boxes and press rolls; the Ingersoll-Rand air compressor, and the battery of sand filters, which filter the 14,400,000 gallons of water used daily. At the east end of the mill, occupying basement and first floor, are the store rooms and the spacious, completely equipped shops with not a line shaft or a driving belt in sight. Adjoining the substation control room, which incidentally, is a beautiful installation rivaling many a modern public utility station, is the hospital, equipped for any emergency, with X-Ray, operating room, laboratory and with a doctor in constant attendance. A modern cafeteria is also provided for employees. Light, roomy offices occupy the space over the train shed.

If this report of a most stimulating visit to a remarkable mill betrays the enthusiasm of the writer, it is because the experience of finding a perfectly appointed plant, immaculate throughout and ultra modern in every detail is so infrequent. Perhaps, too, the enthusiasm is contagious, and thus partly contracted from the hospitable crew of paper mill men who operate the Anglo Canadian Pulp and Paper Mill and to whom the writer's gratitude for their courteous reception is here recorded, particularly to R. A. McInnis, manager, and George S. Pincott, one of his lieutenants.

Designing Equipment for Chemical Treatment of Oil Distillates

By J. C. Morrell and D. J. Bergman
Universal Oil Products Company, Riverside, Illinois

EDITOR'S NOTE: *Fundamental chemical engineering operations—common to many industries—are involved in carrying out the comparatively simple chemical processes of refining gasoline, kerosene and related oil distillates. In the present paper the writers have discussed all of the chemical engineering factors involved in designing the large scale equipment used in the treating process. The portion of the paper presented in this issue is devoted to the calculation and principles underlying the design of the individual elements. Subsequent portions of the paper will deal with the assembly and construction of these elements and with the operation of the complete treating plant.*

CHEMICAL treatment of oil distillates depends upon two fundamental principles: (1) Efficient contact between the oil and the chemical reagent; and (2) withdrawal of the products of reaction from the treated oil. Efficiency of contact implies good mixing and sufficient time of reaction.

In the application of these two principles, either batch or continuous treating-equipment may be used. In batch equipment, contact between the reagent and oil is obtained by blowing with air, by mixing with mechanical devices such as propellers upon a rotating shaft or by circulating devices such as centrifugal, gear, or rotary pumps. Mechanical methods of mixing are preferable to air-blowing because of the losses caused by evaporation in the air-blowing.

In continuous-treating systems the mixing elements are used in conjunction with settling elements, each individual step or reagent in the treatment requiring a mixing and settling element. The most commonly used devices for obtaining mixing are orifice columns, packed columns, baffled columns or coils, and mechanical methods of mixing.

A number of different types of mixers have been used for obtaining intimate contact between the distillates and reagents used for treating. The orifice mixer, in the writers' experience, has been found most satisfactory. One of the first mixers used in the refining industry was a number of lengths of pipe connected in series by return bends; in some cases as high as fifteen or twenty lengths of pipe were used to obtain only fair mixing. Likewise, a series of return bends connected to one another has also been used with practically as good results as were obtained with the pipe. This would indicate that the main action is the turbulence caused by flowing through the return bend rather than the extra time given by flowing through the pipe alone. The return bends mentioned above have also been used with orifice plates, giving very good results.

Another type of mixing-column is one in which small plates are cut on four radial lines and the vents bent at an angle to form a sort of propeller. These propeller-shaped devices were usually strung on a rod spaced with pipe and fastened so as to reverse the flow from one plate to the next. When these propeller-like devices are free to move, as is sometimes true of this arrangement, inefficient mixing results. This type of mixer can be made more efficient by welding the propeller-like plates upon a rod, but at the best they are not very efficient.

A further development of mixers was the use of baffle plates extending part way across the pipe (usually two-thirds of the diameter) and the use of packing such as Raschig rings, crushed rock, or screened gravel. One of the chief disadvantages of the latter type of mixer is the tendency to plug.

The orifice column has proved one of the most satisfactory devices for obtaining contact between chemical reagents and oil distillates. Intimate contact of oil and reagent can be obtained by pumping them together in proper proportion through a series of orifice plates placed in the pipe. The superficial velocity of the liquid through the pipe should be quite low. For most efficient action per plate, a fairly high pressure drop should be allowed across the plates and the orifice area should be divided

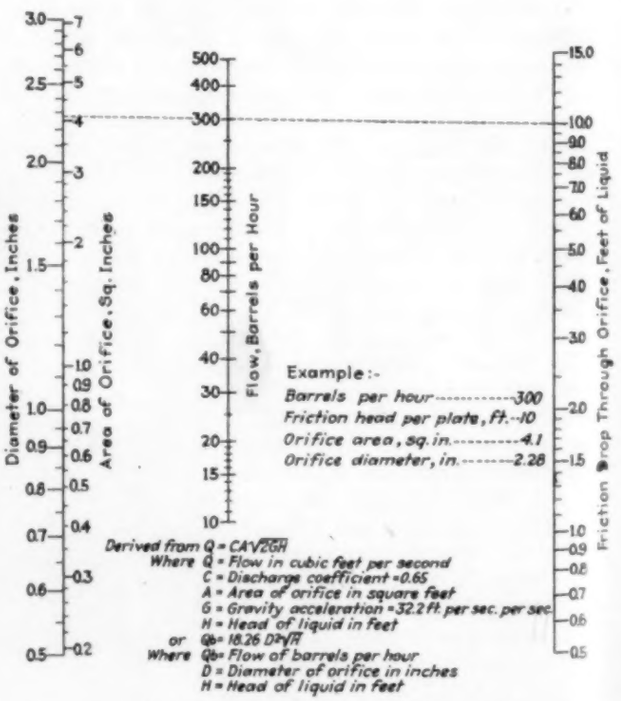

Diameter of Orifice, Inches
Area of Orifice, Sq. Inches
Flow, Barrels per Hour
Friction Drop Through Orifice, Feet of Liquid
Example:-
Barrels per hour----------300
Friction head per plate, ft.--10
Orifice area, sq.in.----------4.1
Orifice diameter, in.-------2.28
Derived from Q = CA√2GH
Where Q = Flow in cubic feet per second
C = Discharge coefficient = 0.65
A = Area of orifice in square feet
G = Gravity acceleration = 32.2 ft. per sec. per sec.
H = Head of liquid in feet
or Qb = 18.26 D²√H
Where Qb = Flow of barrels per hour
D = Diameter of orifice in inches
H = Head of liquid in feet

Fig. 1—Alinement Chart Showing Relation Between Diameter of Orifice, Head of Liquid and Rate of Flow

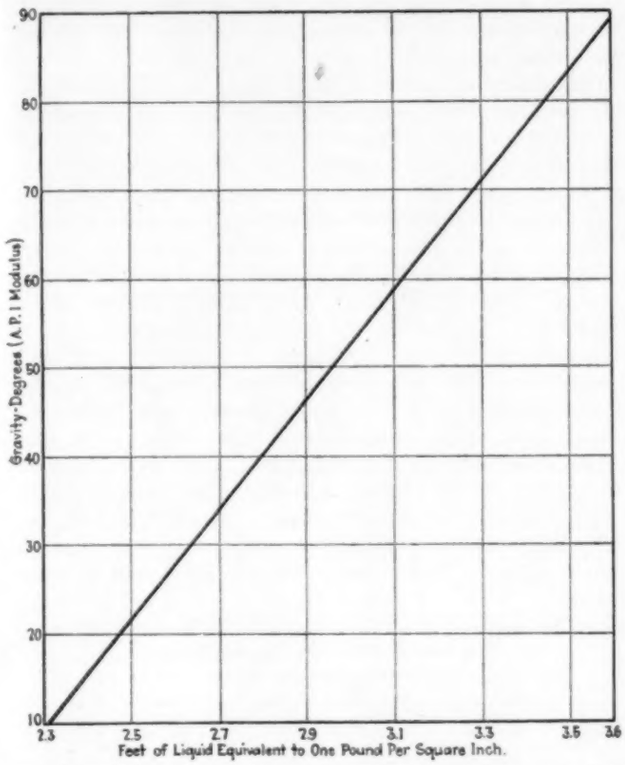


Fig. 2—Relation Between Gravity A.P.I. and Feet of Liquid Equivalent to a Pressure of One Pound Per Square Inch

into several small holes rather than a large one. The energy of the high velocity jets is dissipated on the downstream side in eddies and turbulence, resulting in efficient mixing.

In the design of an orifice column, the familiar orifice formula is used, namely:

$$Q = CA\sqrt{2GH}$$

Where Q = Flow in cubic feet per second
C = Discharge coefficient = 0.65 (For oil distillate)
A = Area of orifice in square feet
G = Gravity of acceleration = 32.2 ft. per sec. per sec.
H = Head of liquid in feet

Or $Q_b = 18.26\ D^2\sqrt{H}$

Where Q_b = Flow in barrels per hour
D = Diameter of orifice in inches
H = Head of liquid in feet.

Problem No. 1—An example of the design of an orifice column for mixing sulphuric acid and oil for a treating plant will be given. From experience it has been found that a 30 to 40 lb. back pressure, (pressure drop) exclusive of the liquid head upon the column will give very good contact in mixing, using approximately 15 to 20 orifice plates in the column.

In the present example it is desired to design a column for acid-treating 300 bbl. of oil per hour. Hence, with a total of 30 to 40 lb. back pressure (pressure drop) and 15-20 plates, the drop of pressure per plate in pounds per square inch is 2. This is equivalent to 5.98 ft. of 52 deg. Bé. distillate, the latter being chosen as a typical pressure distillate. Applying the formula

$$Q = CA\sqrt{2GH}$$

$$A = \frac{300 \times 5.61}{3600} \times \frac{1}{.65} \times \frac{144}{8.02\sqrt{5.98}} = 5.28$$

Diameter of orifice required in inches 2.59

As this orifice area is rather large, it is desirable to divide it into several smaller orifices, making proper allowance for approximately $\frac{1}{16}$ in. clearance between the edge of the plate and the pipe. An 8-in. pipe has been found suitable for this capacity, hence the clearance would be

$\frac{1}{16}$ in. $\times$ 8 $\times$ 3.14	= 1.57 in.
Net area required for orifices = 5.28 — 1.57	= 3.71 in.
Area required for each of six holes	= 1.62 in.
Diameter of hole	= 1.89 in.

Therefore, the orifice plates are made 7.95 in. in diameter to fit inside an 8-in. standard pipe and six $1\frac{7}{8}$-in. diameter holes are drilled in each plate.

In order to simplify the use of this formula, the writers have made an alinement chart (Fig. 1) showing the relationship between the area and diameter of the orifice; the head of liquid, and the rate of flow. An example is given for the use of this chart. The particular example shows that for a capacity of 300 bbl. per hour, with a chosen friction-head per plate of 10 ft. of liquid, the orifice area in square inches required would be 4.1 in. and the orifice diameter for a single opening would be 2.28 in. This total area may be conveniently divided into two openings each of $1\frac{5}{8}$ in. diameter; or into four openings of $1\frac{1}{8}$ in. diameter. The distribution of the orifice openings and the arrangement of the plates within the column will be discussed later.

The head of liquid in feet can be reduced to pounds per square inch if the specific gravity of the liquid is known. Fig. 2 is a curve showing the relationship between the gravity in degrees A.P.I. modulus of the liquid—i.e., the oil undergoing treatment—and the feet of liquid equivalent to one pound per square inch. Fig. 3 is a similar curve showing the relation between specific gravity and the feet of liquid equivalent to 1 lb. per sq.in.

Problem No. 2—It is desired to construct an orifice column for the acid treatment of pressure distillate, for a plant with a capacity of 150 bbl. per hr. Choosing a total back pressure (pressure drop) of 30 lb. on the orifice column exclusive of the liquid head, and a column containing 16 plates, the back pressure (pressure drop) upon each plate would be 1.9 lb. The specific gravity of the oil undergoing treatment is 0.72; this is equivalent to 3.1 ft. per lb. or a total of 5.9 ft. per plate.

At a charging capacity of 150 bbl. per hour and 5.9 ft. of head per plate, the orifice area may be read directly from the alinement chart and is found to be 2.7 sq.in. per plate. Allowing a total of $\frac{1}{16}$ in. clearance around the plate for an 8-in. pipe, equivalent to an area of 1.56 sq.in. would leave an orifice area of 1.14 sq.in. This may be divided on the plate into the two openings of approximately $\frac{7}{8}$ in.

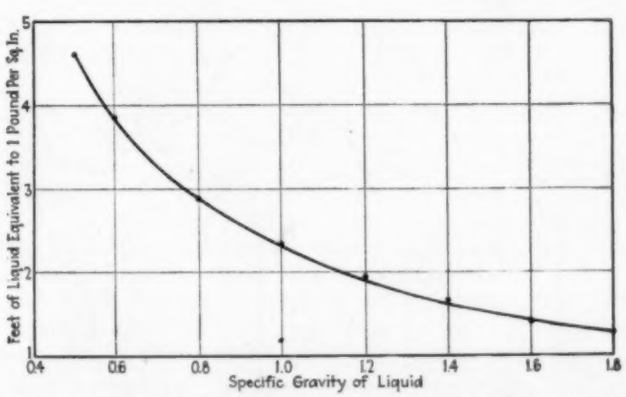


Fig. 3—Relation Between Specific Gravity and Feet of Liquid (See Fig. 2)

The construction of an orifice column may be made as follows:

1. The pipe may be slotted on alternate sides and the orifice plate recessed by the thickness of the pipe on one side. The plate is dropped in the slot with the recessed side next to the slot and the slot closed by a heavy weld. It is important that this weld be heavy to avoid leakage under the pressure of the system.

2. Flanged nipples may be used with an orifice-plate between each pair of flanges. Both of these methods of construction are shown in Fig. 4.

3. The plates may be drilled in the center and threaded on a rod. The plates are secured at proper distances upon the rod by using locknuts or they may be welded to the rod, in which case threading is dispensed with. The whole arrangement may then be dropped into the pipe, allowing about $\frac{1}{16}$ in. clearance on the whole circumference. This clearance must be deducted from the total orifice area. This method of construction is shown in *A* of Fig. 5.

Design of Baffle-Plate Column — The baffle-plate column alone is not an efficient mixer, but when used in conjunction with an orifice column it serves the purpose of maintaining over an extended time the thorough mixture made by the orifice column and also permits recirculation of sludges through a separate mixing element. The baffle-plate column thus serves a very useful purpose as an auxiliary mixing device and has the advantage of low pressures, e.g., 20 baffles spaced 1 ft. apart in a 6-in. column with liquid flowing through at the rate of 200 bbl. per hour gives a pressure drop of less than 10 lb.

The construction of the baffled column is similar to that of the orifice column and a specific example is shown in *B* of Fig. 5. The manner in which the baffled column is used in conjunction with the orifice column will be fully described and illustrated in a later portion of this article.

Packed Mixing Columns—Very few data are available upon the efficiency of the packed column as a mixing device in the chemical treatment of oil. The results obtained with these columns are not as good as those obtained with orifice columns; but, on the other hand, the packed column is more efficient than the baffled type or the propeller type.

The packed column is usually made by filling a length or several lengths of pipe with Raschig rings, screened gravel, or crushed granite. These mixers are relatively cheap and give good results with a comparatively low pressure drop. The packing materials mentioned are more satisfactory for acid mixers than for caustic mixers. Packed mixers plug rather easily, especially when screened gravel or crushed granite is used. Raschig rings are more satisfactory. For caustic mixers, short iron or steel nipples may be used as packing.

In order to determine the back-pressures of packed columns, a series of tests were carried out with lengths of pipe packed with 1-in. Raschig rings and with $\frac{3}{4}$ to 1 in. gravel. A 4-in. galvanized pipe, 20 ft. long, was packed with 1-in. Raschig rings and fitted with pressure gages and a meter; water was then run through under a steady flow from the city mains. Another set of experiments was made under the pulsating flow from a triplex pump. The results shown in Table I were obtained.

Table I—Friction Drop of Water Flowing Through Twenty Feet of 4-In. Pipe Packed with 1-In. Raschig Rings

G.P.M.	Pressure Drop Pounds	Pounds Per Foot	Feet Head Per Foot	G.P.M. Per Sq.In.	Superficia Velocity Ft./Sec.
Steady Flow from City Mains					
45	22	1.10	2.50	3.54	1.13
44	20	1.00	2.30	3.45	1.11
40	16	0.80	1.84	3.14	1.01
33	12	.60	1.38	2.59	.83
29½	9	.45	1.04	2.32	.75
26	7½	.38	.88	2.04	.66
24	6	.30	.69	1.88	.61
22½	5	.25	.58	1.77	.57
Pulsating Flow From Triplex Pump					
77	61½	3.08	7.11	6.02	1.94
75	57	2.85	6.58	5.90	1.89
71	53	2.65	6.11	5.57	1.79
69	49	2.45	5.65	5.42	1.74
66	45	2.25	5.19	5.18	1.66
63	41	2.05	4.73	4.94	1.59
60	37	1.85	4.27	4.71	1.51
57	33	1.65	3.81	4.47	1.44
54	29	1.45	3.35	4.24	1.36
50	25	1.25	2.88	3.93	1.26
45	23	1.15	2.65	3.53	1.13
40	21	1.05	2.42	3.14	1.01
32	18	.90	2.07	2.52	.81
25	11½	.57	1.33	1.96	.63
20	10	.50	1.15	1.57	.50

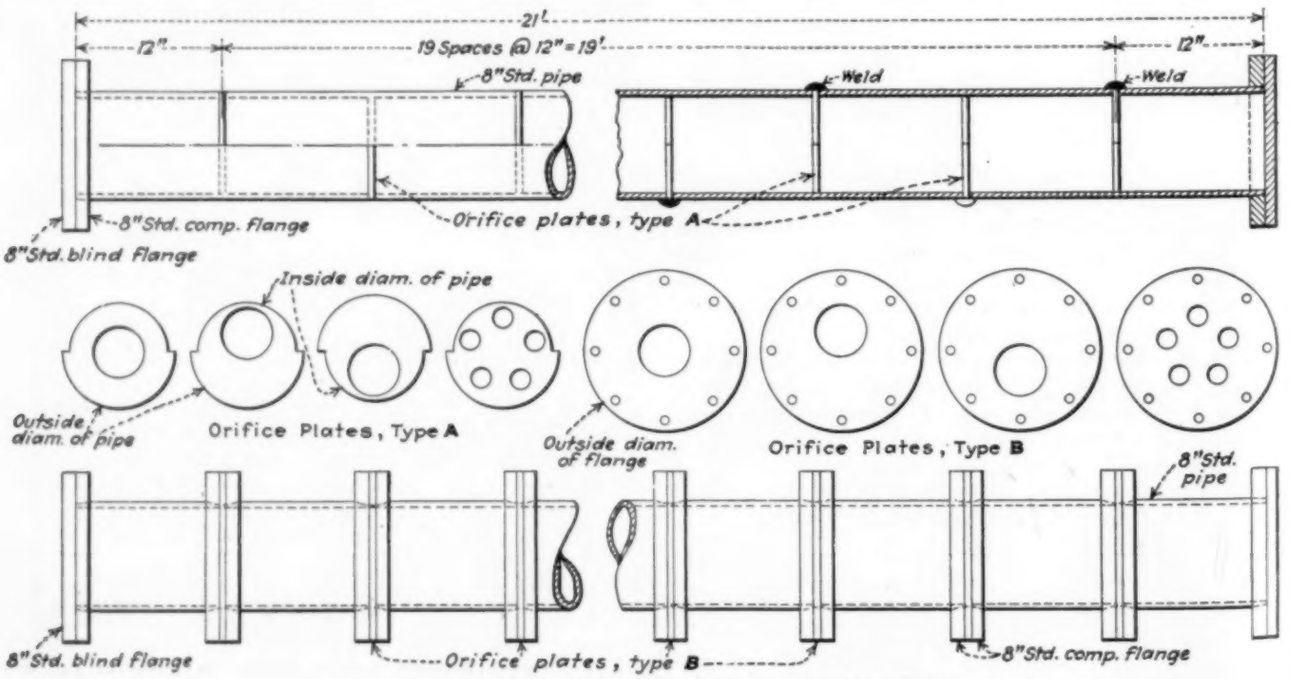


Fig. 4—Construction Details for Two Types of Orifice Mixers

The experiments were repeated for pulsating flow with ¾ to 1 in. of screened gravel; the results obtained are tabulated in Table II. These results have been plotted in Fig. 6 showing the gallons of water per minute per square inch of pipe cross-section against the friction drop in feet of liquid per foot length. The curves indicate that the friction drop in feet of liquid per foot of length rises more sharply than the increase in rate of flow,

Table II—Friction Drop of Water Flowing Through Twenty Feet of 4-In Pipe Packed with ¾ to 1 In. of Screened Gravel

G.P.M.	Pressure	Friction Drop, Lbs. per Foot	G.P.M. per Sq.In.	Ft. Head per Foot	Superficial Velocity Foot per Sec.
56	55	2.75	4.40	6.34	1.41
54	53	2.65	4.24	6.10	1.36
51	49	2.45	4.00	5.65	1.28
49	46	2.30	3.85	5.30	1.23
47	42	2.10	3.69	4.84	1.19
45	38	1.90	3.53	4.38	1.13
42	34	1.70	3.30	3.92	1.06
40	30	1.50	3.14	3.45	1.01
38	26	1.30	2.98	3.00	.96
34	22	1.10	2.67	2.53	.86
30	18	.90	2.35	2.07	.76
26	14	.70	2.04	1.62	.65
22	10	.50	1.73	1.15	.55
19	8¼	.42	1.49	.97	.48

i.e., a direct proportionality does not exist between the two.

As an example, the design of a mixer using 1-in. Raschig rings to handle 300 bbl. per hour or 5 bbl. per minute of 52 deg. Bé. distillate with a pressure drop of 25 lb. per sq.in. will be shown:

For a 20-ft. length of pipe, the pressure drop is 1.25 lb. per ft. or

$$\frac{1.25 \times 2.304}{0.77 \text{ sp. gr. of distillate}} = 3.74 \text{ ft. of head per ft. of pipe.}$$

The viscosity of this distillate will not be greatly different from that of water, so from the curve the rate of flow through the pipe will be 4.45 gal. per min. per sq.in. of pipe.

$$\text{Pipe area required, sq.in.} = \frac{5 \times 42}{4.45} = 47 \text{ sq.in. internal area of pipe}$$

Pipe diameter = 7.75 in.
Use 8 in. diameter pipe.

Jet Mixers—A Venturi tube or a number of smaller tubes in parallel are sometimes used to mix two fluids. A high velocity jet of oil flowing through the throat of the nozzle induces suction, which can be used to draw in the chemicals. This type of mixer is most efficient when approximately equal quantities of liquids or fluids are to be mixed. In the chemical treating of oil, the amount of reagent is small compared to the quantity of oil, hence positive control of the introduction of the reagent is necessary.

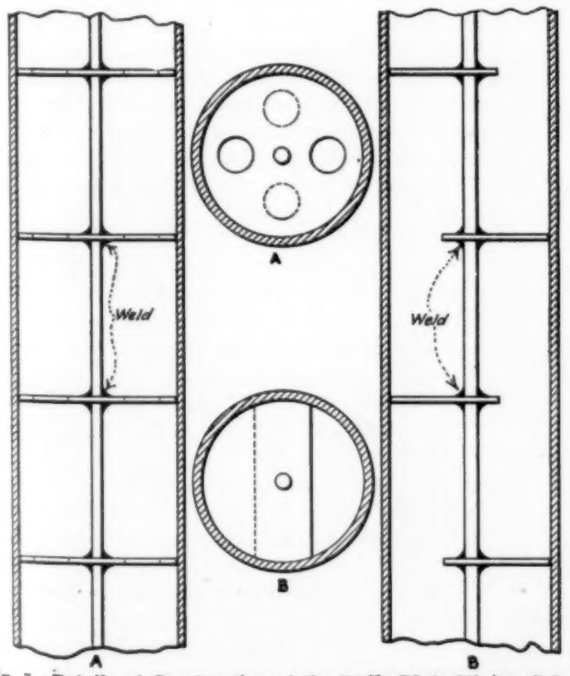


Fig. 5—Details of Construction of the Baffle-Plate Mixing Column

The principle of mixing in the jet-type of mixer is excellent, but the chief disadvantage is the short time of contact of the reagent and the oil. On the other hand, this general type of mixer will serve excellently as an auxiliary to bring about preliminary mixing of the reagents and the oil and may be supplemented by an orifice or baffled column to maintain the mixture and to provide the time factor. This can be conveniently done as the jet mixer is one of low back-pressure. This principle has been applied in a jet-mixing device which has been placed upon the market.

Mechanical Mixers—Mechanical mixers have been used for mixing reagents and oil. These mixers usually consist of a shell or container equipped with a shaft provided with paddles. A recirculating effect may be obtained by placing a cylindrical shell, open at both ends, within the larger container. The stirring is carried on in the inner shell, the liquids circulating between the annular space of the inner and outer shell.

A similar effect is sometimes obtained by giving a slight backward pitch to the propeller and moving the liquids forward with the charging pump. The use of baffles in the shell will also increase the mixing action. The shell containing the rotating shaft may be vertical or horizontal. All of these mixers can be applied to the treatment of the oil with the various reagents used, viz., sulphuric acid, caustic soda or plumbite solution.

Pumps—High-velocity rotary or centrifugal pumps for direct feed of oil and reagent or for recirculation of acid and caustic sludges and oils function as mixing devices, but should always be supplemented by other mixers of the kinds described.

One method of obtaining efficient mixing with the pump is to pump the distillate backward or reverse the direction of rotation through a centrifugal pump which has had the impeller cut down to a small diameter. The churning action of the pump running backward gives exceptionally intimate contact between the reagent and the distillate with a comparatively small pressure drop. A similar scheme is to use a two-stage pump in which the second stage impeller has been cut down in diameter and reversed.

Pumps in the system should be placed low enough to maintain a head on the suction side. This provision will avoid losing suction with light, "gassy" distillates. The oil-feed pumps may be of the duplex-piston type; or centrifugal, gear or rotary pumps may be used. The latter maintain a uniform discharge pressure, but all types may be used with good results. The pumps should be fitted with good stuffing boxes to avoid leakage of the light distillates. For a direct-acting steam-pump of the duplex type, a speed governor or pressure governor should be used to maintain a uniform flow.

All motor-driven pumps should have the motor and starting switch in a separate closed room to prevent the possibility of a spark igniting the vapors. The pump should be fitted with acid-resisting bronze or be made of cast iron. It should have ample stuffing boxes, as light distillates are very difficult to hold.

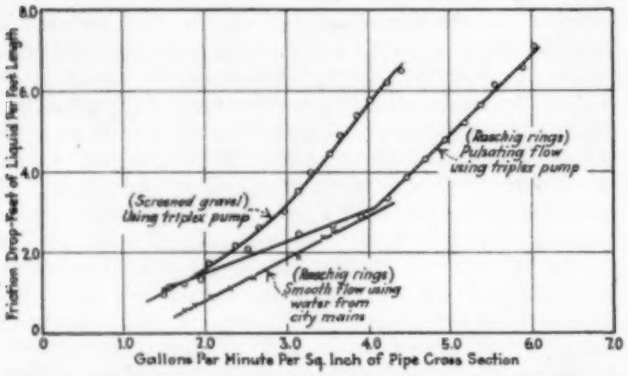


Fig. 6—Friction Drop of Water Through Pipe Packed with (A) One-Inch Raschig Rings and (B) Three-Fourths Inch Screened Gravel
(From experiments with 4-in. pipe).

Where direct-acting steam-pumps are used, either a Mason speed governor or a pressure governor should be fitted to the pump to maintain a uniform flow to the equipment. Acid-resisting alloys such as bronze or Monel metal should be used in making the rods. Ordinarily a soft asbestos wick-packing will be found to give good results on this type of work. Rubber packing is particularly satisfactory for alkalis.

Blow-Cases—The use of blow-cases as proportioning devices for feeding reagents such as acid and caustic is old, but the practice has continued to a large extent up to the present time. For continuous-treating systems, the use of proportioning reagent-feed pumps is recommended. However, blow-cases will be described together with the method of proportioning the reagents.

If blow-cases are used, they should be made heavy enough to withstand the full refinery air pressure even after some corrosion has taken place. It will usually be found advantageous to set them on the ground or in a pit, so as to obtain gravity flow to them from storage tanks. If acid and caustic can be pumped into them, however, a tank set vertically will be found to have advantages in that gage glasses can be used to afford a quick and accurate check on the amount of reagent used. Each blow-case should have a check valve in the air line to prevent blowing acid back in the line in case the refinery air pressure should drop. A $\frac{3}{4}$-in. pressure-reducing valve will be found satisfactory for ordinary use. The pressure on the blow-case may then be varied to suit the requirements and to give a close control of the amount of reagent used.

Tanks of appropriate size set vertically on the ground may be used as blow-cases for acid. caustic soda and plumbite solution. These should be approximately one-half inch thick, so as to withstand 50 or 60 lb. air pressure after considerable corrosion. It is desirable to have either a gage glass on the side of each blow case, or add a 2-in. nipple tapped or welded to the top of the tank and capped, so that a gage stick may be used to check the rate of use of acid or caustic solution. A $\frac{3}{4}$-in. air line leads to each blow case. In each line a $\frac{3}{4}$-in. pressure reducing valve is placed. This will maintain a constant pressure on the blow-case ranging from 15 to 60 lb. A pressure gage reading to 100 lb. should be installed on each blow-case. The solution lines from the blow-cases to the suction of the pump may be made 1 in. Close to each blow-case should be installed a pair of flanges with a Monel metal screen of about 40 mesh to prevent clogging the orifice in the solution line. The orifice plate is interposed between two flanges in the acid line.

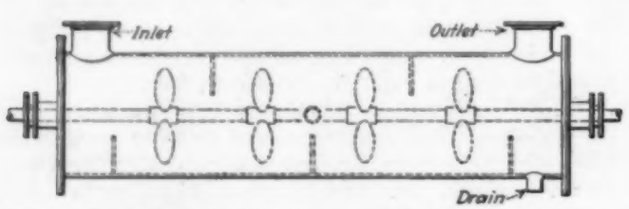


Fig. 7—Type of Mechanical Mixer Used in Chemical Treatment of Oil

For the caustic or plumbite solution, $\frac{1}{4}$-in. orifice will feed 4 gal. per min. with a 16 lb. differential across the orifice. This corresponds to a 2 per cent treatment. Two blow-cases are provided for these solutions, in order to give a full treatment without interruption.

For a 1 per cent caustic soda or plumbite treatment, a $\frac{3}{16}$ in. orifice with 12 lb. differential will give 2 gal. per minute. The pressure differential between the blow-case and the suction of the pump can be varied by means of the air reducing valve to give the desired flow of solution through the orifice.

Calculation of orifices for proportioning with blow-cases will be considered in a subsequent portion of this paper which will also include a discussion of the complete assembly of the treating plant.

Hydrogenating Low-Grade Coal in Germany

WILLIAM T. DAUGHERTY, American Trade Commissioner in Germany, reports considerable recent progress in hydrogenating low-grade coals. Pioneer research on this was done, of course, by Dr. Frederich Bergius, of Heidelberg, but the process was improved by the German dye trust which supplied a catalyst to the operation. It seems to be too optimistic to suppose that this oil from coal will emancipate Germany entirely from petroleum imports in future. Its first years of production can scarcely overhaul increasing consumption by the automotive industry alone in Germany. Furthermore, lignite reserves for raw material for the synthesis are not inexhaustible. Under the ammonia operation alone, lignite reserves were estimated to last but another 100 years, and since then, the oil from coal synthesis and the fact that hydrogen will be produced over lignite instead of coke, will cut into these reserves all the sooner.

Incidentally, a great part of the secret of the Leuna work's capacity to throw its synthetic production of ammonia, methanol and oil from coal into world competition, doubtless depends upon its future plans to produce hydrogen from lignite instead of coke. The former costs about 75 cents per ton on the spot, while coke, hauled from the Ruhr, must cost in the neighborhood of $10 a ton. The Leuna works coke bill has always been a most expensive item.

German rights to the coal hydrogenation process center in the so-called Kobergin company, 65 per cent of whose shares belong to the dye trust while Ges. f. Teerverwertung holds the rest. The latter is putting up a Bergin plant in the Ruhr. Foreign rights center in the International Bergin company, of The Hague, which has recently licensed to a British syndicate rights to promote the process further.

Phenol Recovery Plant Avoids Waste Pollution of Streams

By Hugh E. Jones
Chemical Engineer, Fairmont, W. Va.

THAT UGLY DUCKLING of the modern industrial brood, trade waste disposal, has frequently on closer examination been found to be no outcast but a source of pride and profit to its forbears. The present example, while it is not a spectacular producer of income, has developed into a self-supporting individual with a capacity for doing much good through the elimination of what has threatened to become a most serious nuisance, the pollution of streams used for drinking water. This erstwhile pariah, phenol-bearing wastes from coke oven and gas plants, has been converted into a respectable member of several communities.

During the past ten years many cities, including Milwaukee, South Chicago, Toronto, Cleveland, Buffalo, South Pittsburgh and Wheeling, have complained at times of disagreeable and unpalatable drinking water. In many cases, this has been traced directly to phenol-bearing industrial wastes, made disagreeable through the necessary chlorination at city water supply filtration plants. The phenol content of the water may usually be traced to the calcium phenolate present in the lime waste from coke oven plant ammonia stills. Not all of the phenol produced by coal distillation remains in the coal tar. A small amount dissolves in, and is present as somewhat less than 0.6 per cent of the ammonia liquor. When the liquor is subsequently degassed in the lime stills, calcium phenolate is produced in small quantities. The frequent procedure of disposal of still waste in convenient streams invites pollution from the free phenol resulting from the interaction of the waste with carbon dioxide and other acid constituents of the water. The water, later sterilized with chlorine for drinking purposes, then contains a minute but appreciable contamination of chlorophenols which possess a most disagreeable taste even in nearly infinitesimal proportions. The minimum concentration which can be tasted is not definitely known. E. F. Kohman, director of the Research Laboratory of the National Canners Association, found that one part of chlorophenol in 750,000,000 parts of water was appreciable. The Koppers Company, on the other hand, has determined the limit as being ten times this concentration. Whatever the true limit may be, it is recognized that phenolic wastes are likely to render water unpalatable and to militate against public health due to the consequent decreased consumption of drinking water.

It is only within the last few years that a generally satisfactory process for controlling this nuisance has been evolved. Previously three methods, each of limited application, but still much used, were the only recourse. In the first, waste liquors are run into impounding reservoirs large enough for surface evaporation to take care of daily production. The second system pumps waste liquor to the quenching sump, from which it is withdrawn for cooling the hot coke. This process is largely used today, although coke so quenched is practically unfit for domestic use due to its foul odor and discoloration. The third method relies upon bacterial action in the city sewers through which the waste is pumped to cause destruction of the phenol.

No satisfactory chemical method of treating the waste has been developed despite the considerable attention the problem has received. A usable cure for the nuisance has recently been found to lie in removal of the phenols, not from the still waste, but rather from the ammonia liquors before they go to the lime still. Two processes for this purpose have been developed, the patented Tiddy-Heffner or distillation method and the benzol extraction method. The latter was pioneered by the chemical engineers of the National Tube Company at the Lorain, Ohio, plant. Further development and refinement of this method were made by D. W. Wilson for the Iroquois Gas Corporation, Buffalo, New York, by R. M. Crawford for the Hudson Valley Coke and Product

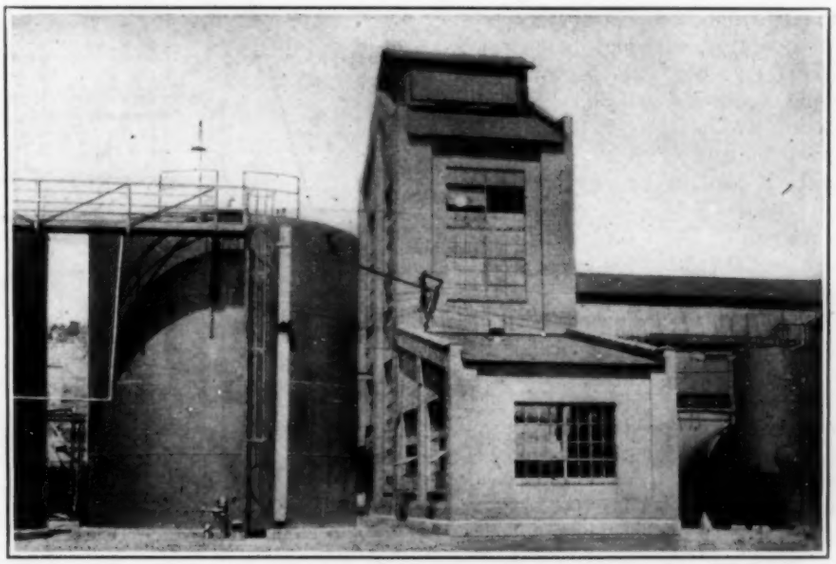


Fig. 1—Outside Tanks and Building of the Phenol Recovery Plant

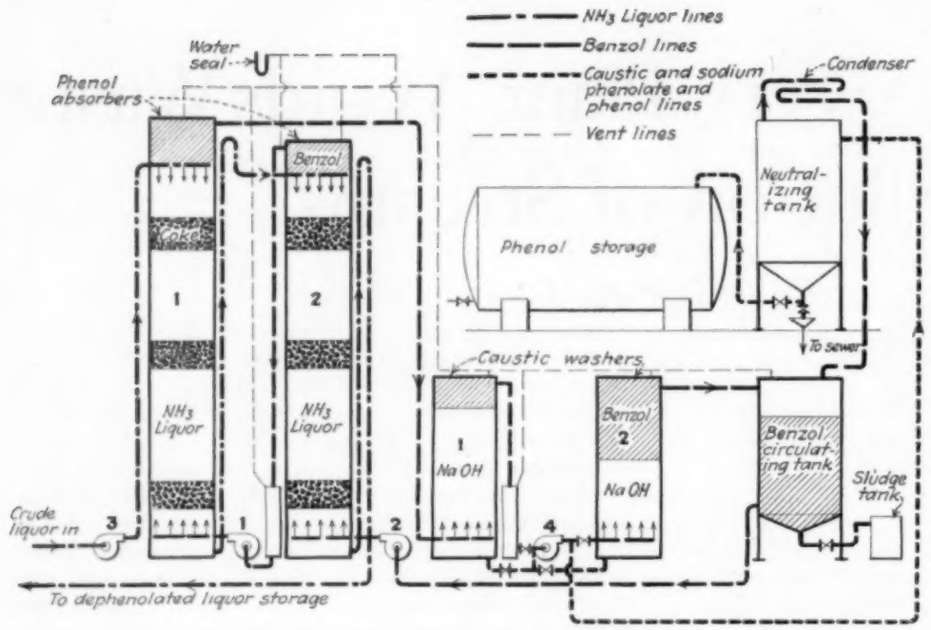


Fig. 2—Flow Diagram Showing Stages of the Recovery Process in Detail

Corporation, Troy, New York, and by the writer for the Domestic Coke Corporation, Fairmont, West Virginia.

When it had been found that still wastes from the Domestic Coke Corporation's by-product coke plant at Fairmont, were responsible for the pollution of drinking water for cities on the Monongahela River for some distance below Fairmont, immediate steps were taken to correct the trouble. After an attempt at using the wastes to quench the coke was abandoned because of the unpleasant features of the product, work was begun on a benzol extraction plant, as this method had shown the best results in the laboratory.

In January, 1927, within three months after construction was started, the extraction plant was in operation, recovering 72 per cent of the benzol. Shortly, this recovery was increased to 96 per cent where it has since been maintained. The labor requirement is small, requiring the part-time attention of only one operator, although some 36,000 gal. per day of ammonia liquor are treated. As the unit was designed to handle future expansion of the coke plant, it has to be operated only about 12 days per month at present. There are, however, no stand-by losses and the starting-up and shutting-down operations are extremely simple. Operation is practically automatic as the pumps will run for days without adjustment. The production of 25,000 gal. of crude phenol per year makes the plant self-supporting.

In brief, the process consists in scrubbing the crude ammonia liquors from the coke plant through motor benzol which absorbs the phenol. The benzol is then stripped of phenol by washing with caustic soda solution, producing sodium phenolate which, upon acidification, yields a readily marketable crude phenol. The recovered benzol is re-circulated with only sufficient make-up to compensate for losses.

Details of the plant and operations are shown in the illustrations reproduced herewith. Fig. 1 presents a general view and shows at the left storage for treated ammonia liquor, in the center the building addition required to house the pumps, caustic washers and benzol circulation tank, and at the right the equipment for neutralization of sodium phenolate and storage of the resultant phenol. A flow diagram of the entire process is given in Fig. 2, while Fig. 3 is a conventionalized piping layout for the apparatus.

The two phenol absorption towers shown at the left of Fig. 2, are housed in the original ammonia still room beyond the additions. These consist of 6-ft. diameter steel towers, the one 36 ft. high and the other two ft. shorter. Each tower has a liquid distributor, top and bottom, the upper consisting of four 1-in. inlets placed above a perforated plate, and the lower, of a series of inlets placed beneath a plate containing $\frac{3}{8}$-in. perforations. Three 36-in. beds of egg-size coke are supported on wire screens at intervals in each tower to serve as mixers and distributors.

One tower is the taller of the two to permit gravity flow of ammonia liquor from one to the other. Crude

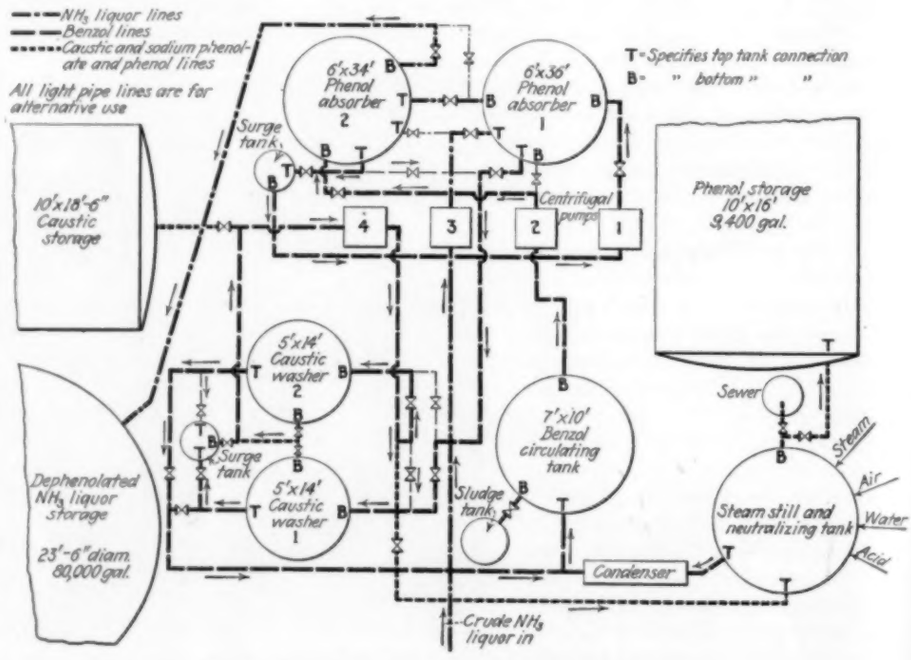


Fig. 3—Conventionalized Piping Lay-out of the Plant

ammonia liquor is supplied at the top of No. 1 absorber by No. 3 pump and is drawn off at the bottom of each tower in a pure or semi-purified condition as the case may be, and discharges through an inverted U of adjustable height. Each U is made of ordinary pipe and fittings as is indicated in Fig. 4. Adjustment of height is made by rotating the upper portion of the U around the center line of the street ells. Once the proper height is determined, no change need be made unless a variation in operating requires a change in liquor levels.

AMMONIA liquor from absorber No. 1 is run to the distributor at the top of absorber No. 2, while from the latter, the treated ammonia liquor is returned to the dephenolated ammonia liquor storage tank. Benzol overflowing the top of No. 2 absorber discharges to the surge tank and is pumped by No. 1 pump into the distributor at the bottom of tower No. 1. Piping is so arranged, as is shown in Fig. 3, that either absorber may be used alone in case one is down for repairs, although when both are in service, No. 1 is always first in the series. When but one absorber is in use, one pump and surge tank are thrown out of service.

The two caustic washers, next in series, are used to separate phenol from the circulating benzol. They consist of two identical steel tanks 5 ft. in diameter by 14 ft. high, equipped with distributors placed beneath the perforated plate in the bottom of each. Each tank is provided with an overflow at the top, and a drain at the bottom for removing the exhausted caustic solution. Fig. 3 shows the piping so arranged that either tank may be used alone or may be made the first in the series. One tank may be discharged and supplied with fresh caustic, while the other carries the load. When this is being done, the surge tank and pump which ordinarily take the overflow from the first washer and pass it to the distributor of the second, are out of the line and the pump is used to drain the one tank, pump its contents to the neutralizing still and refill the tank with fresh caustic.

From the top of the second of the two washers, an overflow line discharges to the benzol circulating and storage tank, which is of steel, 7 ft. in diameter by 10 ft. high, equipped with a conical bottom. The tip of the bottom discharges to a sludge tank into which any emulsions which form in the system and collect in the conical bottom may be run. At a higher point a connection is made to the benzol circulating pump No. 2.

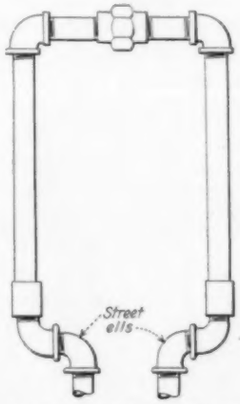


Fig. 4—Adjustable U Overflow

The next piece of apparatus consists of another conical bottom steel tank, 6½ ft. in diameter by 12 ft. high, equipped with agitating air, water, steam and sulphuric acid connections. Either a coil or live steam may be used for heating. A condenser, connected to the top, discharges to the benzol storage tank. At the bottom are connections whereby the contents may be run to the sewer or blown by air to the phenol storage tank.

In order that the liquid levels in the system may be able to surge, each tank is vented at the top. Also, to prevent siphoning from one tank to another, vents in each of the overflow lines are required. At some of these vents it was found that there was a decided suction while at others there was pressure. It was found that air was being sucked into the system and then pumped out again ladened with benzol vapor. Consequently, considerable effort was devoted to the working out of a suitable venting system. The final form is shown in Fig. 2. A water seal is provided at one point to prevent the building up of pressure in the apparatus. This seal, located on the line venting the two benzol overflow lines from the absorbers, is tied into the rest of the system through the open spaces in the top of the absorbers. It is interesting to note that it was not until this arrangement was arrived at after several different venting hook-ups had been tried that satisfactory operation was attained.

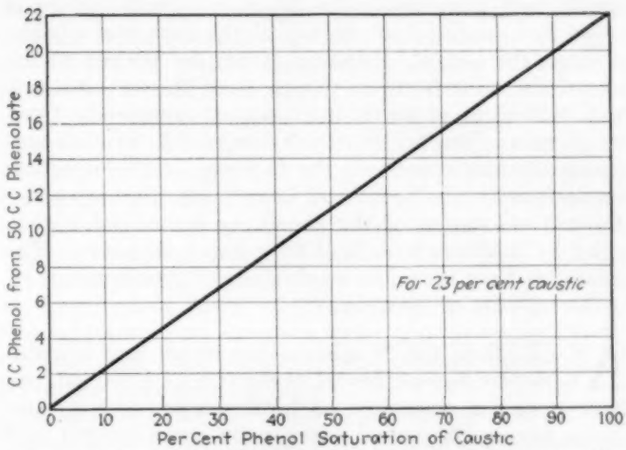


Fig. 5—Curve for Determining Degree of Phenol Saturation of the Sodium Hydroxide Solution in the Caustic Washers

Each inverted U in the two ammonia overflow lines is vented to the atmosphere. No benzol losses occur here since only ammonia liquor flows through these lines.

All iron gate valves of the clip type are used exclusively throughout the plant with the exception of a single lubricated plug cock used as a choke valve on the benzol overflow from No. 1 absorber. This is used to regulate the velocity of benzol flow and prevent turbulence in the caustic washers. Piping consists of 3-in. for all gravity flow lines and 2-in. for all pump discharges. Small centrifugal pumps driven by 1-hp. motors handle the entire circulating load.

THE process in some detail next deserves attention. In the stages of both ammonia liquor treatment and benzol recovery, full use is made of the differences in specific gravity between ammonia liquor and benzol on the one hand, and benzol and sodium hydroxide solution on the other. The process likewise depends upon the mutual insolubility of these components. At the same time, the principles of counterflow and continuity of operation are employed insofar as is possible.

The coke plant produces about 440,000 gal. per month of 8 gm. per liter total NH_3 ammonia liquor, using 60 Koppers ovens. In addition to the phenol content of the ammonia liquor, there are small amounts of cresols, higher tar acids, pyridine, naphthalene and tar oils present. The greater part of these impurities is removed from the ammonia liquor by solution in the benzol in the phenol absorbers. Benzol is introduced into the bottom of the second absorber, and by reason of its lesser specific gravity, rises through the ammonia liquor and collects at the top of the tower. From here it overflows into a surge tank and is pumped into the bottom of the first

tower, and rises again to the top. Crude ammonia liquor is introduced at the top of the first tower, sinks through the benzol, discharges from the bottom to the top of the second tower, passes down through this one and discharges at the bottom, almost completely freed of phenols. The height of the inverted U in each ammonia discharge controls the location of the interface between ammonia liquor and benzol. A thorough mixing and absorption of the phenol by the benzol is provided by the three coke beds built into each tower. The coke beds have shown no tendency to clog or break down in over a year of operation.

AN EXTRACTION efficiency of 96 per cent is maintained by flowing benzol at the rate of 1,800 gal. per hour against a circulation of 1,500 gal. per hour of ammonia liquor. A venturi meter in the ammonia still feed line is used to measure the flow of the latter, while an orifice meter in the discharge of No. 2 pump measures the benzol flow.

Phenolized benzol overflows the top of No. 1 absorber and enters the distributor at the bottom of the first of the caustic washers. The washers are started a little more than half full of 23 per cent caustic soda solution. Benzol collects at the top of each, leaving its phenol behind as sodium phenolate. The volume of the caustic mixture increases directly with the volume of the phenol absorbed, so that when the caustic is exhausted, the aqueous mixture nearly reaches the tank overflow. As the greater part of the phenol is absorbed by the first washer, the second is nearly fresh when the first is exhausted. The second can thus carry the load while the first is emptied by pump No. 4 to the neutralizing tank and then refilled with a fresh charge, ready to go on the line in the second place. A washer charge is exhausted about once every ten days.

Benzol overflowing from No. 2 washer contains about 0.01 per cent of phenol. It discharges to the benzol circulating tank where it is held before entering the system again.

It is found that there is a gradual accumulation of tarry matter in the benzol which slightly reduces the extraction efficiency of the plant. It has proved advisable to re-distill all of the benzol once every six months. This also reduces the content of tarry matter in the crude phenol and decreases the formation of emulsions in the system.

A PRACTICAL test was developed empirically in the laboratory for determination of the degree of saturation of the caustic solution in the washers. It is sufficiently accurate for smooth and economical operation and eliminates a tedious laboratory test requiring several hours of the chemist's time. Each morning the operator withdraws about 200 c.c. of the sodium phenolate-caustic mixture from the first washer into a separatory funnel. After the contents of the funnel have stood for fifteen minutes, the occluded benzol rises to the top, after which 50 c.c. of the caustic mixture are run to a beaker and neutralized with concentrated sulphuric acid. The beaker contents are poured into a graduate and after a few minutes the volume of the black phenol is read. Comparing this volume with Fig. 5, the per cent saturation of the caustic solution is read directly. It should be noted that the per cent saturation obtained holds true for existing conditions but is not absolute. The actual consumption of caustic has been found to be about 15 per cent more than the theoretical requirement calculated from the volume of moisture- and impurity-free phenol produced.

During the circulation of the benzol through the liquor and the caustic, a certain amount of emulsion is formed which accumulates in the bottom of the benzol circulating tank. When a caustic washer is emptied, this emulsion is drawn off into the sludge tank and is pumped into the neutralizing tank along with the sodium phenolate. The sodium phenolate contains, as has been mentioned, impurities of cresols, higher tar acids, pyridine, naphthalene and tar oils. There is also a certain amount of occluded benzol. These impurities, especially the benzol, must be removed to prevent contamination of the final crude phenol. Therefore, the sodium phenolate solution is subjected to distillation with coil steam and the distillate, which is chiefly benzol, is condensed and run back to the benzol circulating tank. As soon as all of the benzol is distilled out of the phenolate, the vent is opened, live steam is turned directly into the phenolate and the remaining impurities are driven into the atmosphere.

LIBERATION of free phenols from the purified phenolate solution is now accomplished by adding 60° Bé. sulphuric acid while the charge is being agitated with air. The acid reacts to form free phenols and sodium sulphate. As soon as the solution becomes neutral, it is allowed to rest for a short time until the black phenol rises to the top of the white sodium sulphate solution. The sodium sulphate solution, as it is of no practical value, is drawn off into the sewer and the phenol is then blown by air pressure into the phenol storage tank. Approximately 720 gal. of phenol of the following volumetric composition are separated out after each neutralization.

Phenol	54 per cent	Water	16 per cent
Cresols	23 per cent	Tarry matter	7 per cent

The elimination of losses, as is always the case with a newly developed process, was one of the greatest problems of this plant. The benzol vapor losses were largely prevented by the vent system already described. Another loss of benzol of considerable importance, although largely only an apparent loss, is the benzol which is dissolved in the ammonia liquor and passes out of the system into the dephenolated ammonia liquor storage tank. This was found to amount to 0.14 per cent by volume of the ammonia liquor at 40 deg. C. and 0.16 per cent at 23 deg. C. However, while 600 to 800 gal. per month of benzol are lost to the system by this means, the benzol is actually returned to the gas stream of the coke plant when the dephenolated liquor is treated in the ammonia still, and subsequently is recovered at the benzol scrubbers. The true loss to be charged to the phenol plant is merely the proportionate cost of operating the benzol plant exclusive of any material cost for benzol. This cost is largely offset by the savings in lime required to operate the ammonia stills, since calcium phenolate is no longer formed. This fact has been checked in operation.

THIS PHENOL recovery plant is the fourth in the country to use the method of benzol extraction. It differs in most details from the other plants, and, within the knowledge of the writer, it maintains the highest extraction efficiency of any plant now built. Even at a lower efficiency, such a plant should prove an excellent investment for any coke oven installation, not only as it eliminates an economic waste but as it also fosters the good will of the communities which the plant serves.

Lead Pigments Present Highly Developed Technology

By J. B. Nealey
American Gas Association

WHITE LEAD was probably the first pigment in the processing of which chemical treatment was called upon to play a part. Today it still represents one of the world's most important pigment and base materials, while in its manufacture, more of it is still made by a process only slightly differing from the original, centuries old, than is produced in any other way. This treatment, known as the Dutch process, is the one used by the National Lead Company in its various plants. The company's Chicago branch is described herein.

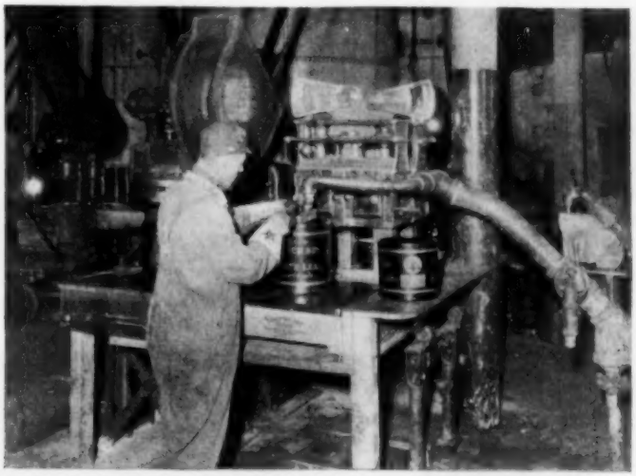
The plant covers two city blocks and in its six modern buildings produces not only white lead in both the dry and paste forms but also litharge, red oxide of lead and various alloys such as babbitt, solder and type metals. The buildings comprise the corroding yard, white lead mill, oxide furnace room, oxide mill, alloy and metal manufacturing department and warehouse.

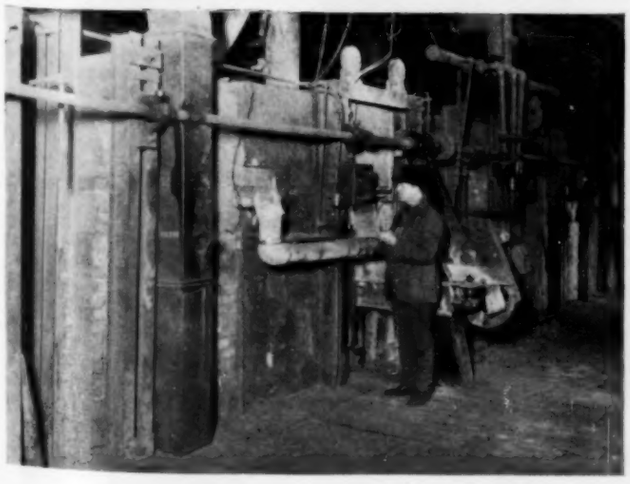
The corroding yard, used in the Dutch process, consists of 64 stacks or rooms about 20 ft. square and 40 ft. in depth, open at the top. These rooms are filled from top to bottom with layers of earthenware pots filled with lead buckles and containing weak acetic acid in the bottom, with the layers interspersed with layers of spent tan bark.

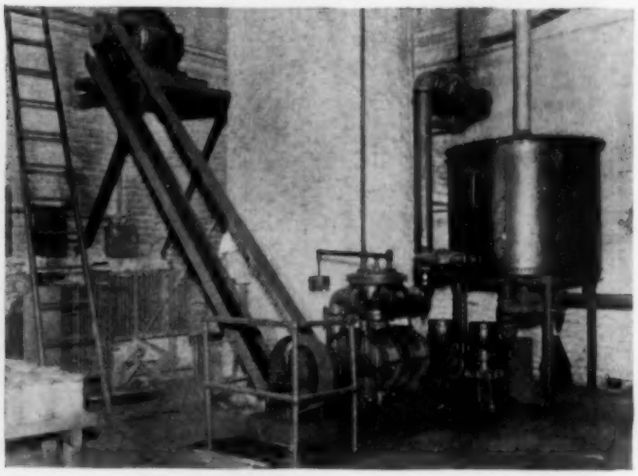
To form the buckles, metallic lead is cast in the form of thin perforated disks about five or six inches in diameter, the holes permitting free circulation of the acid fumes. The disks are charged into the earthen pots which are approximately 8 in. in diameter with the lower part forming a small cup. This cup is filled with weak acetic acid, the fumes from which attack the buckles without contact between the acid and the lead.

In making the stack a layer of wet, spent tan bark is spread about 20 in. deep on the floor of the room. The corroding pots are then set in close rows on top of the bark, and more bark is packed between the edges of the outer pots and the walls of the room. Planks are then laid over the pots and more bark placed on the planks, followed by another layer of pots and so on until the stack is built up to the top of the room. A ventilating duct leads from each layer to the top, by means of which moisture is removed and the temperatures may be controlled to a certain extent.

Fermentation of the bark forms carbon dioxide while the resulting heat, which approximates 180 deg. F., causes the acid to fume. Circulating air and moisture and acetic acid fumes corrode the lead buckles and produce basic lead acetate. The carbon dioxide then acts to form basic lead carbonate or white lead. This liberates normal lead acetate which itself has strong solvent action







Paste Mills Above Are Used for Fine Grinding of White Lead in Water. Below Are Gas-Fired Furnaces Where Lead is Converted to Litharge

Above is an Automatic Scale for Filling Cans with White Lead Ground in Oil. Proportioning Equipment for Air and Gas is Shown Below

on lead, thus assisting the decomposition process. The process requires from 100 to 125 days when most of the lead has changed and the stacks are stripped, the white contents of the pots poured into chests and the chests removed to the white lead mill by overhead electric cranes.

The white lead mill is housed in a 3-story and basement building. The equipment consists principally of a series of beaters, rolls, water mills, and screens. The uncorroded lead is separated from the white lead and the latter is crushed, elevated to the second floor and screened and the oversize returned to the rolls. The fines are then put into grinding hoppers and tubs which feed into water mills on the first floor. The product is water floated through drag boxes and rake tubs on the second floor, the overflow from which is sufficiently fine to pass through silk bolting cloth. The milky mixture is then put through vibrating silk-covered screens after which it is elevated to settling tanks, some 20 in number, on the third floor. Here the process splits with part of the settled product dried in copper pans and pulverized in grinders, ready to be packed for the trade as dry white lead.

The settled mass from the remainder of the settling tanks is dropped by gravity into pulp mixers on the second floor where it is mixed with linseed oil and the water gradually eliminated. It is then run to the first floor and through chasers or chilean mills equipped with oil stones and the resulting product is put into two-story storage tanks, ready for the fillers. These products, dry and paste are used variously in paint, glass, pottery, pigments, medicines, insecticides and chemicals. The different departments producing them are served by screw conveyors for pastes and by pumps where the materials are fluid.

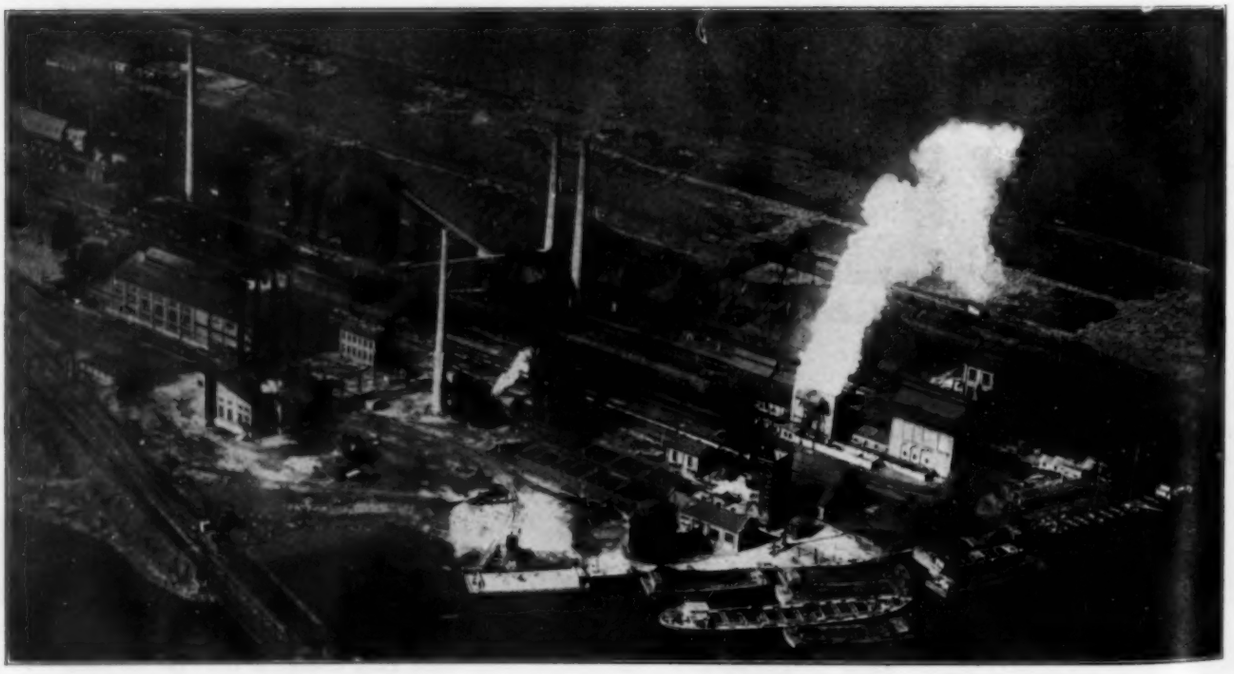
Litharge and red oxide of lead are produced in the oxide furnace room where are located 16 reverberatory furnaces, some of which are heated by gas while others utilize coal as a fuel. These furnaces are of brick, suitably stayed and are 14 ft. wide, 12 ft. deep and 8 ft. high. The upper chamber or hearth is of sufficient size to accommodate a circular pan 9 ft. in diameter while the lower part is so designed as to receive a container on a truck, into which the contents of the pan are dropped through a hole in the bottom.

These pans take 3,000 lb. of pig lead at a charge and the molten lead is continually agitated by a vertical shaft with 14 blades. The gas-fired furnaces have 18 gas burners arranged in a row on one side, all firing across the top of the pan. The waste gases pass out and down through a chamber on the other side of the furnace in which is located a coil of pipe. Air blown through this coil is preheated. This air is forced into the heating chamber or hearth to furnish an excess of oxygen to promote oxidation. The product is litharge.

This blast of air is also used as a mechanical means for clearing or blowing away the litharge as it forms on top of the molten charge. If this were not done the litharge would form a protecting coat and prevent further oxidization of the mass. The oxide, in the form of a dry yellowish powder, is then taken from the furnace. Ground and screened in the oxide mill, it is then packed ready for the trade.

The gas burners in these units are furnished with a mixture of gas and primary air in the proper ratio for complete combustion, so that no secondary air is required. This reduces fuel consumption, gives a hotter fire, decreases the time per batch and thereby increases production.

Red oxide of lead is made from litharge which has been ground and returned to the furnace for another burning, but at a lower temperature. The product is a brilliant orange-red colored powder, ground to various degrees of fineness as may be required. Of the many uses for these two materials, driers for paints, varnishes, and lineoleum, and use in storage batteries, printing inks, pigments, petroleum refining, match manufacture and rubber goods are representative.



Airplane View of the Plant of the Seaboard Byproduct Coke Company at Kearny, N. J.

Water Softening with Barium Salts

By C. J. Rodman

Vice-President and General Manager, The Buckeye Jack Manufacturing Company, Alliance, Ohio

IN TREATING any boiler feed water the cost of chemicals is by no means a measure of economy. The cost of pure dry steam under its most efficient pressure and temperature delivered to the prime mover is the vital economic consideration. A great many factors influence pure steam cost such as: concentration of feed water within boilers, resultant foaming and priming hazards, blow-down with its inexcusable waste of heat and water, deposits of scale with its many subsequent troubles and poor heat conductivity characteristics, boiler outage with its consequent maintenance and repair costs, the numerous factors of pitting and corrosion, the damages resulting from clogged superheaters and reduced superheat, dirty and wet steam with its increased wear and tear on cylinders, and corroded and eroded turbine blades, necessity of increased oil consumption, or inefficient lubrication and a great many other factors should be adequately considered when computing the cost of water treatment and pure dry steam.

Every water supply for feed water, or cooling purposes should be examined with critical chemical engineering analysis before a recognized method of water treatment is given. Commercially, it is found that the use of lime-barium water softeners are particularly adapted to waters that are impaired by an excessive sulphate content.

In Table I are shown representative operating data for lime-barium water softeners, giving the location, source of water, use to which the purified water is adapted, an analysis of the raw and treated water and various remarks which are self-explanatory. Tenney has pointed out (in *Power*, Vol. 59, No. 17, 1924, page 647) that in water treatment in Cahokia the use of barium hydrate is to advantage in treating Mississippi River water, high in scale-forming substances, and with unusually high turbidity. Advantages are shown in spite of the excessive cost of barium hydrate over that of barium carbonate. The use of barium hydrate as a water softening chemical has been in operation for many years both in America and abroad. Methods have been devised whereby the less expensive barium carbonate can be utilized to advantage with practically the same efficiency as the soluble barium hydrate. Barium carbonate without the use of lime water, however, will not produce efficient operating results.

In Table II for example, is found an analysis of raw water from Marion, Ohio, and also the resulting treatment with lime-barium carbonate as compared with the lime-soda ash treatment.

The new lime-barium carbonate treatment as developed in the United States is somewhat more complex, chemically, than the lime-barium carbonate treatment as used originally in Germany, yet the results are relatively more advantageous. In the German barium treatment, the softening process depends upon the use of saturated lime water in connection with the practically insoluble barium carbonate. As the raw water enters the softener, it comes in contact with these chemicals, the lime water being added in the required proportions, whereas the barium carbonate is present in greatly excess quantities, so that the softening is carried out in the proportion as incrustants are present in the raw water. This process

Table I—Representative Operating Data for Lime-Barium Water Softeners

Location	Hourly Capacity in Gal.	Date Installed	Source of Water	Use	Raw Water* TH.	Raw Water* CH.	Raw Water* NCH.	Treated Water* TH.	Treated Water* CH.	Treated Water* NCH.	Remarks
Nacosari, Sonora, Mexico	2,100 4,000	1920 1920	Reservoir Springs	Make up for Diesel Engine	13 13	8.9 8.9	5.0 5.0	3.1 3.1	3.0 3.0	0.1 0.1	Softeners 5 miles apart, jackets and piping entirely scale free. No cooling water trouble whatsoever. Formerly lost several engine heads.
Hurley, N. Mexico	14,000	1916	Apache Spring	Water tube boilers	12.3	7.1	5.2	1.2	1.2	0	Analysis from month's drip samples, 1925. Open boilers every 4 mos. to blow out soft sludge. No pitting. No tube losses. Daily blow off 1½ gal. No foaming and priming.
Stag Canyon Br. Dawson, N. Mex.	10,000	1921	Coal mine spring stream	Waste heat boilers	16.3	10	6.2	3.4	3.4	0	Untreated water produced very hard scale. Now no pitting or corrosion, foaming or priming.
Jerome, Arizona	4,000	1924	Copper mine water	Steam shovels, locomotives	27	15	12	1.1	1.1	0	Replaced lime soda softener, previous serious troubles eliminated. Excellent results.
Hayden, Arizona	7,000	1916	Wells and Gila river seepage	20 per cent make-up for W. T. boilers	28.5	14.5	14.5	1.5	1.5	0	Installation saves over $18,000 yearly in maintenance and operation. Previous serious troubles entirely eliminated.
Santa Rita, N. Mex.	12,000 6,000	1916 1925	Copper mine Water	Steam shovels and 36 locos.	41.5	11.5	30	2.7	2.7	0	Replaced lime soda equipment. Formerly 32 locomotives to round house daily, now average less than 1 per day.
Bisbee, Arizona	7,500	1918	From mines, Czar river	Steam shovels, locomotives	52	20	32	3.0	3.0	0	Replaced lime soda equipment. No sign of pitting or corrosion. Excellent operating results.
Sonoro, Mexico	21,000	1922	Wells	Waste heat boilers	12.5	8.0	4.5	1.8	1.8	0	Raw water mixed with condensate. Oil entirely removed without coagulation. Boilers flushed out once every 6 months.

* TH—Total hardness, CH—Carbonate hardness, NCH—Non-carbonate hardness.

Table II—Comparative Results of Treating Marion, Ohio, Water with Lime-Barium Carbonate and Lime-Soda Ash Methods

	Raw Water, Gr. per Gal.	Ca-Ba Carb., Gr. per Gal.	Lime Soda Ash, Gr. per Gal.
Calcium carbonate	19.00	1.25	4.00
Calcium sulphate	8	.....	.....
Magnesium sulphate	13	.....	.....
Iron and alumina	0.7	Trace	Trace
Silica	0.7	Trace	Trace
Suspended matter	0.5	.....	.....
Alkali sulphates	5	2.0	27.25
Alkali chloride	0.05	0.05	0.05
Sodium carbonate	.....	.....	3.25
	46.95	3.30	34.55

is practically free from complicated dosing devices and other moving parts that are present in the usual lime and soda ash processes.

The new treatment, first, gives the mixture of certain quantities of lime and barium carbonate and preliminary treatment with steam, thus partially converting a proportion of the barium carbonate to barium hydroxide. The softening agents then introduced into the water, are barium and calcium hydroxides and also barium carbonate. Barium hydroxide is very much more soluble and ionized than the calcium hydroxide. The first reaction then is between barium hydroxide and the dissolved CO_2 and the calcium and magnesium bicarbonates, and other soluble magnesium salts. If there is not sufficient barium hydroxide to remove all of these, they will be removed by the lime. As a matter of fact in a mixture of the two hydroxides both will act at the same time, although the barium hydroxide is the more active of the two. This, for all purposes of removing the portion of the alkaline earths, has precisely the same result as lime alone, with the distinct difference, however, that the reaction product of barium hydroxide and the CO_2 or the CO_3 ion is barium carbonate in the molecular or colloid condition. The water then contains an excess of lime, calcium sulphate, sodium chloride, sodium sulphate, organic sulphates and barium carbonate and possible hydroxide. Looking at the possible reactions in this mixture and considering that the solution is relatively very dilute, the salts are, therefore, mostly in ionized condition.

The sulphate radical will not be present in solution with the barium ion, but will be precipitated as barium sulphate. This can take place through the medium of $BaCl_2$, $BaCO_3$, or $Ba(OH)_2$. Sodium carbonate will not be present in the same solution with $BaCl_2$, $Ba(OH)_2$, $CaCl_2$ and $Ca(OH)_2$. The possible final products in solution can be then only $Ca(OH)_2$, NaOH, NaCl, Na_2SO_4 and organic matter.

Fig. 1—Lime-Barium Water Softener for Cooling Water for Diesel Engines at Nacozari, Sonora, Mexico

From some experimental work, when the SO_4 concentration was as high in Mahoning River water (15 grains per gallon), it was impossible to remove more than 85 per cent of the calcium sulphate from pure solutions by barium carbonate in the aggregated condition, in the sense of the reaction—

$$BaCO_3 + CaSO_4 = BaSO_4 + CaCO_3$$

The reaction was much improved in the presence of small quantities of $Ca(OH)_2$. This was due to the formation of some $Ba(OH)_2$. However, it was only possible to obtain the final elimination of all the $CaSO_4$ when Na_2SO_4 and NaCl were present. This was particularly true of Na_2SO_4. The reasons are apparent from the reactions—

$$Na_2SO_4 + BaCO_3 = Na_2CO_3 + BaSO_4$$
$$CaSO_4 + Na_2CO_3 = Na_2SO_4 + CaCO_3$$

The final elimination of the $CaSO_4$ was therefore accomplished by the sodium carbonate, and the Na_2SO_4, in this case acting as a catalytic agent. There was no final elimination of Na_2SO_4 in this way until all the $CaSO_4$ was removed. The same holds true with NaCl. The chief point of the NaCl, being more highly ionized, seemed to be in its effect in hastening the precipitation of $BaSO_4$. Since the $BaSO_4$ must pass through the colloid stage and because colloids are readily precipitated by certain electrolytes, its action is apparent. In other words, the NaCl forced the precipitation of the $BaSO_4$ and physically put it into a more readily filterable form.

The sodium sulphate was eliminated finally in proportion to the amount of $Ca(OH)_2$ present.

$$BaCO_3 + Na_2SO_4 = Na_2CO_3 + BaSO_4$$
$$Na_2CO_3 + Ca(OH)_2 = 2NaOH + CaCO_3$$

This reaction was not perfect, equilibrium being reached when 0.3 grain per gallon of $Ca(OH)_2$ was still present. From later experimental work it appears as though this could readily be accomplished.

The elimination of sulphates both organic and inorganic was complete with the exception of the sodium sulphate over and above that used in the $Ca(OH)_2$ elimination. In this way the concentration will be reduced, which in the case of Mahoning River water, amounts to about a 60 per cent reduction.

Formation of NaOH, and the elimination of Na_2SO_4 and $Ca(OH)_2$ are the chief points of difference between the method as worked out here and that used in Germany. In the German process there is practically no formation of barium hydroxide and therefore no NaOH. This leaves the total alkalinity of the water as $Ca(OH)_2$ and $CaCO_3$. The German barium carbonate treatment is used in this country in the Southwestern section with success, as well as in various places in the Middle-West. Installations at East Alton, St. Louis, Missouri and at Middletown, Ohio, illustrate the success of the Reisert barium carbonate system in treating Middle-Western waters, high in boiler incrustants and alkali sulphates. (See Table II.)

Barium carbonate treatment was tried out by various investigators years ago in the United States, but their results were not successful on account of their failure to get all of the barium sulphate beyond the colloid stage and therefore, made it unfilterable. This was due to the absence of any electrolyte which was sufficiently ionized to force the coagulation. This is now overcome very effectively by keeping the NaCl content up to at least one grain per gallon. This seemed to be the minimum amount necessary to avoid ineffective coagulation and filtration of the barium sulphate.

The U. S. Bureau of Mines [R. E. Hall, *Mechanical*

Engineering, Vol. 46, November, 1924, page 810, and Vol. 47, January, 1925, page 49] has made a study of the formation of scale. Hall found that the formation of hard adherent scale was not dependent on the so-called incrusting salts in the water but upon the relative content of sulphate and carbonate ions in the concentrated boiler water. When the sulphate content became too high, hard scale was formed. The introduction of sufficient carbonate stopped scale formations. It made no difference if the SO_4 or CO_3 were combined with sodium, calcium, or magnesium. When the ratio of sulphates to carbonates exceeded a certain point, crystallized calcium sulphate was precipitated. When this ratio fell below this point the calcium was precipitated as the carbonate. The calcium sulphate forms the adherent scale and the calcium carbonate will appear as a sludge. Any calcium carbonate in the hard scale was held there by occlusion during the formation of the $CaSO_4$.

Let us now consider what the treated water will be like under the various methods of treatment. In Table III appears a representative analysis of Mahoning River water during the dry season (1) and when the rainfall is more abundant (2).

The solubility of $CaCO_3$ is ordinarily considered as in pure water, which is about 1.5 gr. per gallon. However, in a 0.001 normal solution of NaOH its solubility is only 0.25 grain per gallon. This is the condition which we approach in the lime-barium treatment. In the lime-soda ash treatment, however, the excess sodium carbonate again increases its solubility to about that in pure water. The same holds true in the case of the $Mg(OH)_2$. This will explain why a greater elimination is possible with the barium treatment developed here.

There is a slight difference in the different methods of barium treatment. Scale is practically entirely eliminated in either the new or German lime-barium carbonate treatments, except for a very thin coat resembling whitewash in thickness, and which coat has an unusual protection against pitting and corrosion. Under the conditions of high temperature and pressure in a boiler, sodium carbonate will not remain as such, but due to the low partial pressure of CO_2, will be converted into sodium hydroxide. The rate of this conversion is such that 75 per cent of all Na_2CO_2 has become NaOH in 4 hours, and 91 per cent in 6 hours.

Calcium carbonate will be precipitated loosely down to its solubility in the concentrated water at the boiler temperature and pressure. Its solubility decreases with the sulphate content and increases with the temperature and the chloride content. It may also be partially converted into the hydroxide. Other relatively insoluble salts such as $Mg(OH)_2$, SiO_2, Fe_2O_3 and some organic matter will also be precipitated.

Table IV will, therefore, show the composition of the concentrated boiler water, based on the above and as worked out by the Bureau of Mines and from actual tests and analysis. This is based on the water being concentrated ten times.

Table III—Representative Analysis of Mahoning River Water During Dry Season (1) and When Rainfall is More Abundant (2)

	Raw Water		Lime Soda Ash		U. S. Lime Barium		German Lime Barium		Zeolite	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
CO_2	0.3	0.5	.....	....	...	...	...	...	.....	....
$CaCO_3.HCO_3$	0.2	2.0	.....	....	...	...	...	...	.....	....
$MgCO_3.HCO_3$	0.1	1.0	.....	....	...	...	...	...	.....	....
$MgSO_4$	4.0	1.0	.....	....	...	...	...	...	.....	....
$CaSO_4$	15.0	4.0	.....	....	...	...	...	...	.....	....
Na_2SO_4	4.0	1.0	24.54	6.44	1.5	...	4.0	1.0	24.54	6.44
NaCl	5.0	1.0	5.0	1.0	5.0	1.0	5.0	1.0	5.0	1.0
$NaHCO_3$	....	...	.....	....	...	...	...	...	0.3	3.20
NaOH	....	...	0.8	0.8	Tr.	Tr.	...	...	.....	....
Na_2CO_3	....	...	2.5	2.5	...	...	...	...	.....	....
$Ca(OH)_2$	....	...	.....	....	0.3	0.3	1.2	1.2	.....	....
$CaCO_3$	....	...	1.5	1.5	0.7	1.0	1.5	1.5	1.0	1.0
$Mg(OH)_2$	....	...	0.3	0.3	0.1	0.1	0.1	0.1	1.0	1.0
SiO_2	0.5	0.3	0.3	0.2	0.3	0.2	0.3	0.2	0.4	0.4
Organic	5.0	3.0	3.0	2.0	3.0	2.0	3.0	2.0	5.0	3.0
FeO or Fe_2O_3	0.5	0.7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table IV—Tests on Concentrated Boiler Waters
(Quantities in Grains per U. S. Gallon)

	Lime Soda Ash		New Lime Barium		German Lime-Barium		Zeolite	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Na_2SO_4	245.4	64.4	15.0	....	40.0	10.0	245.4	64.0
NaCl	50.0	10.0	50.0	10.0	50.0	10.0	50.0	10.0
NaOH	18.0	24.0	19.0	9.0	....	....	1.0	11.0
Na_2CO_3	10.0	10.0	....	....	....	....	2.0	21.0
$CaCO_3$	1.1	1.2	1.3	1.5	1.3	1.3	1.1	1.2
$Mg(OH)_2$	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
$Ca(OH)_2$	.....	.....	1.3	1.3	1.3	1.3	.....	.....
Total	324.8	109.8	89.9	24.0	91.9	22.9	299.8	107.6
So_4/CO_3	26.2	6.8	13.0	0	51.0	12.8	132.0	3.4

According to the equilibrium constants worked out by the Bureau of Mines and carefully checked on an experimental boiler, there will be no sulphate scale formation if the ratio of the CO_3 radical to the SO_4 radical is less than 1 to 10. This would indicate that some sulphate scale formation is possible with all methods of treatment with Mahoning River water in the dry season, but that conditions are more favorable with the barium treatment developed here than with any of the others.

In regard to foaming and priming [see Faulk, C. W., Foaming of Boiler Water, *Ind. Eng. Chem.*, Vol. 16, November, 1924], these phenomena have been blamed on high concentrations, suspended matter, boiler ratings, sodium carbonate and sulphate, organic matter, etc. In all likelihood all these factors contribute under certain conditions. With the barium treatment the Na_2CO_3, Na_2SO_4 is eliminated, as well as other conditions producing high concentrations. The barium treatment in most practical installations eliminates the foaming and priming trouble; in spite of all the other supposed contributing factors. It would, therefore, appear as though the three factors eliminated—Na_2CO_3, Na_2SO_4 and the high concentrations—were the chief factors in these troubles. Moreover, it is unnecessary to give internal and auxiliary treatment, and equip with the many types of steam purifiers and auxiliary apparatus when proper treatment of feed water is made externally.

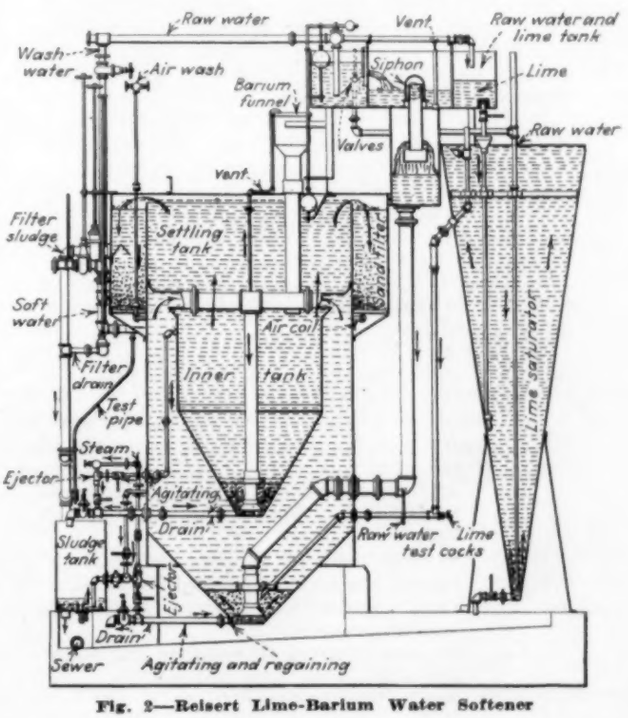


Fig. 2—Reisert Lime-Barium Water Softener

Revised Psychrometric Chart Assists High Temperature Design

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A PROPERLY constructed humidity chart is found especially valuable in making air calculations such as in the design of drying apparatus. To be of the greatest advantage such a chart must not only cover the range of temperature desired, but must also be formulated from data known to be accurate. In reviewing the literature for such a chart in connection with experimental work in drying lignite, it was deemed advisable to construct a high temperature psychrometric chart along conventional lines using more recent data which were considered best suited for this purpose.

William M. Grosvenor (Trans. Am. Inst. Chem. Eng., Vol. I, 1908) called attention to the fact that when dealing with defined conditions, calculations for dryer design could be carried out with great ease. The system of units he proposed are used here with but slight modifications, and are given as follows:

Basis: One pound of dry air.

1. — Absolute Humidity (H) is the weight in pounds of water vapor carried by one pound of dry air.

Percentage Humidity is the weight in pounds of water vapor carried by one pound of dry air at a given temperature, divided by the weight in pounds of water vapor which one pound of dry air would carry if completely saturated at the same temperature.

2. — Dew Point ($D.P.$) is the temperature at which water exerts a vapor pressure that is equal to the partial pressure of the water vapor in the air. If the air is cooled below this temperature, water will begin to condense.

3.—Humid Heat (s) is the quantity of heat required to raise one pound of air, plus whatever water vapor it carries, one degree Fahrenheit.

4. — Latent Heat of Water Vapor (r) is the quantity of heat necessary to convert one pound of liquid water to water vapor without change of temperature.

5.—Humid Volume ($H.V.$) is the volume in cubic feet of one pound of dry air plus the water vapor it contains.

6.—Saturated Volume ($Sat.V.$) is the volume in cubic feet of one pound of dry air saturated with water vapor.

7.—Total Heat (T_H) above 0 deg. F. of a saturated mixture may be considered as made up of three distinct factors:

(a) The heat required to raise the temperature of the air from 0 deg. F. to the wet bulb temperature.

(b) The heat required to raise the temperature of the water contained in the saturated mixture from 0 deg. F. to the wet bulb temperature.

(c) The heat required to vaporize the water contained in the saturated mixture at the wet bulb temperature.

If it is so specified the second of these factors, namely the heat of the liquid, may be omitted, thus obtaining a so-called total heat ($T.H.$) which does not include this item.

Construction of Psychrometric Chart.—The accompanying chart is based on the one presented by W. M. Grosvenor, and represents mixtures of dry air and water vapor, the total pressure of the mixture being taken as 29.92 inches of mercury.

The high range of temperature, 40 deg. F. to 700 deg. F., makes it exceedingly useful in the design of drying installations. For the convenience of those who may wish to replot the chart to larger size, a table of the values used is included. These values have been obtained either directly from generally accepted sources or calculated by means of suitable equations.

The following items, with the exception of humid heat, are plotted as ordinates against temperature in deg. F. as abscissas:

Curve A. — Absolute Humidity (H) as lb. of water vapor per lb. of dry air.

Curve B.—Latent Heat (r) as B.t.u. per lb. of water vapor.

Curve C.—Specific Volume ($Sp.V.$) as cu.ft. per lb. of dry air.

Curve D.—Saturated Volume ($Sat.V.$) as cu.ft. of saturated mixture per lb. of dry air.

Curve E.—Total Heat ($T.H.$) above 0 deg. F., neglecting the heat of the liquid, as B.t.u. per lb. of dry air saturated with water vapor.

Curve E'.—Total Heat (T_H) above 0 deg. F., including the heat of the liquid, as B.t.u. per lb. of dry air saturated with water vapor.

Curve F.—Weight of Water Vapor (W_V) as lb. per cu.ft. of the saturated mixture.

In constructing the humid heat curve, the method of Walker, Lewis and McAdams, used in their textbook "Principles of Chemical Engineering," (McGraw-Hill Book Co., 1927), in plotting humid heat against absolute humidity was adopted.

Curve G.—Humid Heat (s) as B.t.u. per deg. F. per lb. of dry air.

In addition to the above, "adiabatic cooling lines" have been constructed.

In calculating the curves the following equations were used:

A—Absolute Humidity (H). The "100 per cent" humidity curve was calculated by means of the equation:

$$H = \frac{p}{29.92 - p} \times \frac{18.02}{29}$$

where H is absolute humidity and p represents partial pressure of the water vapor in the mixture in in. of mercury. The values of p can be obtained from any reliable saturated steam table. For example, the satura-

tion pressure of water vapor at 140 deg. F. is 5.861 in. of mercury; therefore at 140 deg. F.

$$H = \frac{5.861}{29.92 - 5.861} \times \frac{18.02}{29} = 0.1515 \text{ lb. of water vapor.}$$

The percentage humidity curves were obtained by taking the corresponding percentage of the "100 per cent" humidity value at the temperature desired. For example, the value of H at 10 per cent humidity equals $0.1515 \times 0.10 = 0.01515$, while for 50 per cent humidity at the same temperature, $H = 0.1515 \times 0.50 = 0.07575$.

B—Latent Heat of Water Vapor (r). Values of latent heat of water vapor were calculated by means of Henning's Formula (Fan Engineering Handbook, Second Ed., Buffalo Forge Company) given as follows:

$$r = 141.124\ (689 - t)^{0.31249}$$

where r equals latent heat in B.t.u. while t is equal to temperature in deg. F. Thus, at 32 deg. F.:

$$r = 141.124\ (689 - 32)^{0.31249} = 1071.7 \text{ B.t.u}$$

while at 212 deg. F.:

$$r = 141.124\ (689 - 212)^{0.31249} = 969.7 \text{ B.t.u.}$$

C—Specific Volume (Sp.V.). At standard conditions of temperature and pressure (492 deg. Rankine, and 29.92 in. of mercury), one lb. mol of air (29 lb.) occupies a volume of 359 cu.ft. The following equation for $Sp.V.$ is based on the above fundamental data.

$$Sp.V. = \frac{359}{29} \times \frac{(t + 460)}{492} = 11.57 + 0.0252\,t$$

where t equals the temperature in deg. F. Thus at 140 deg F.,

$$Sp.V. = 11.57 + (0.0252 \times 140) = 15.095 \text{ cu.ft.}$$

D—Saturated Volume (Sat.V.). On the basis of one lb. of dry air, saturated volume equals the sum of the specific volume of the dry air plus the volume of the water vapor with which it is saturated. The volume of the water vapor in a saturated mixture was calculated by the following equation:

$$\text{Volume of water vapor} = \frac{359}{18.02} \times \frac{(460 + t)}{492} \times H = \frac{19.92}{492}\ (460 + t) \times H$$

where H is the absolute humidity and t the temperature in deg. F. The weight of water vapor in air saturated at 140 deg. F. as read from the "100 per cent" humidity curve is 0.1515 lb., therefore:

$$\text{Volume of water vapor} = \frac{359}{18.02} \times \frac{460 + 140}{492} \times 0.1515 = 3.680 \text{ cu.ft.}$$

$$Sat.V. = 15.095 + 3.68 = 18.775 \text{ cu.ft. at 140 deg. F.}$$

E—Total Heat (T.H.) above 0 deg. F. neglecting heat of the liquid. This curve was constructed from values calculated by the following equation:

$$T.H. \text{ above 0 deg. F.} = C_{pa}\,(t_w - 0) + r_w H_w$$

where C_{pa} is the mean specific heat of air at constant pressure. For all practical purposes the value of C_{pa} at the wet bulb temperature may be used without serious error. Further, t_w represents wet bulb temperature in deg. F., r_w latent heat of water vapor at t_w and H_w is absolute humidity at t_w.

E'—Total Heat (T_H) above 0 deg. F., including the heat of the liquid. The following equation was used in calculating values for this curve:

$$T_H \text{ above 0 deg. F.} = C_{pa}\,(t_w - 0) + C_{pw} \times H_w\,(t_w - 0) + r_w H_w$$

where t_w equals wet bulb temperature in degrees F., r_w equals latent heat of water vapor at t_w and H_w is absolute humidity at t_w. C_{pw} is taken to mean specific heat of water. For all practical purposes this may be taken as unity. Similarly, C_{pa} represents specific heat of air at t_w and is taken to be the value at the wet bulb temperature. Thus at 140 deg. F.,

$$T.H. = 0.24238\ (140) + 1013.1 \times 0.1515 = 189 \text{ B.t.u.}$$

and

$$T_H = 0.24238\ (140) + (1 \times 0.1515 \times 140) + 1013.1 \times 0.1515$$

$$T_H = 210.21 \text{ B.t.u.}$$

F—Weight of Water Vapor (W_v) per Cu.Ft. of Saturated Mixture. This curve was constructed from data given by W. H. Carrier in the Buffalo Forge Company's Fan Engineering Handbook. It states that the weight of vapor or density in lb. per cu.ft. of saturated vapor at temperature t is given by the following:

$$D_s = \frac{S\ (144 \times 0.4908 \times e)}{53.35 \times (460 + t)}$$

where S equals specific weight of water vapor and may be found as:

$$S = 0.6221 + 0.001815(e)^{\frac{1}{2}} + 0.0000051(e)^{\frac{3}{2}}$$

and where e equals pressure due to vapor in inches of mercury. Thus at 140 deg. F.,

$$S = 0.6268$$

and

$$W_v = D_s = \frac{0.6268\ (144 \times 0.4908 \times 5.861)}{53.35\ (460 + 140)} = 0.008140 \text{ lb.}$$

G—Humid Heat (s). The curve for humid heat was calculated by means of the following equation:

$$s = C_{pa} + (C_{ps} \times H)$$

where C_{pa} equals specific heat of the air at constant pressure, C_{ps} equals specific heat of water vapor at constant pressure, and H represents absolute humidity. The value of C_{pa} equals 0.2375 as determined by Regnault has been commonly used in calculations of humid heat. Carrier (*loc. cit.*) has shown that this value is too low and that the value of C_{pa} equals 0.24112 plus 0.000009 t, as determined by Swan, is more accurate. It was hence used in this calculation. The value of specific heat of water vapor was determined by the following equation also given by Carrier:

$$C_{ps} = 0.4423 + 0.00018\,t$$

where t equals temperature in deg. F.; therefore humid heat is

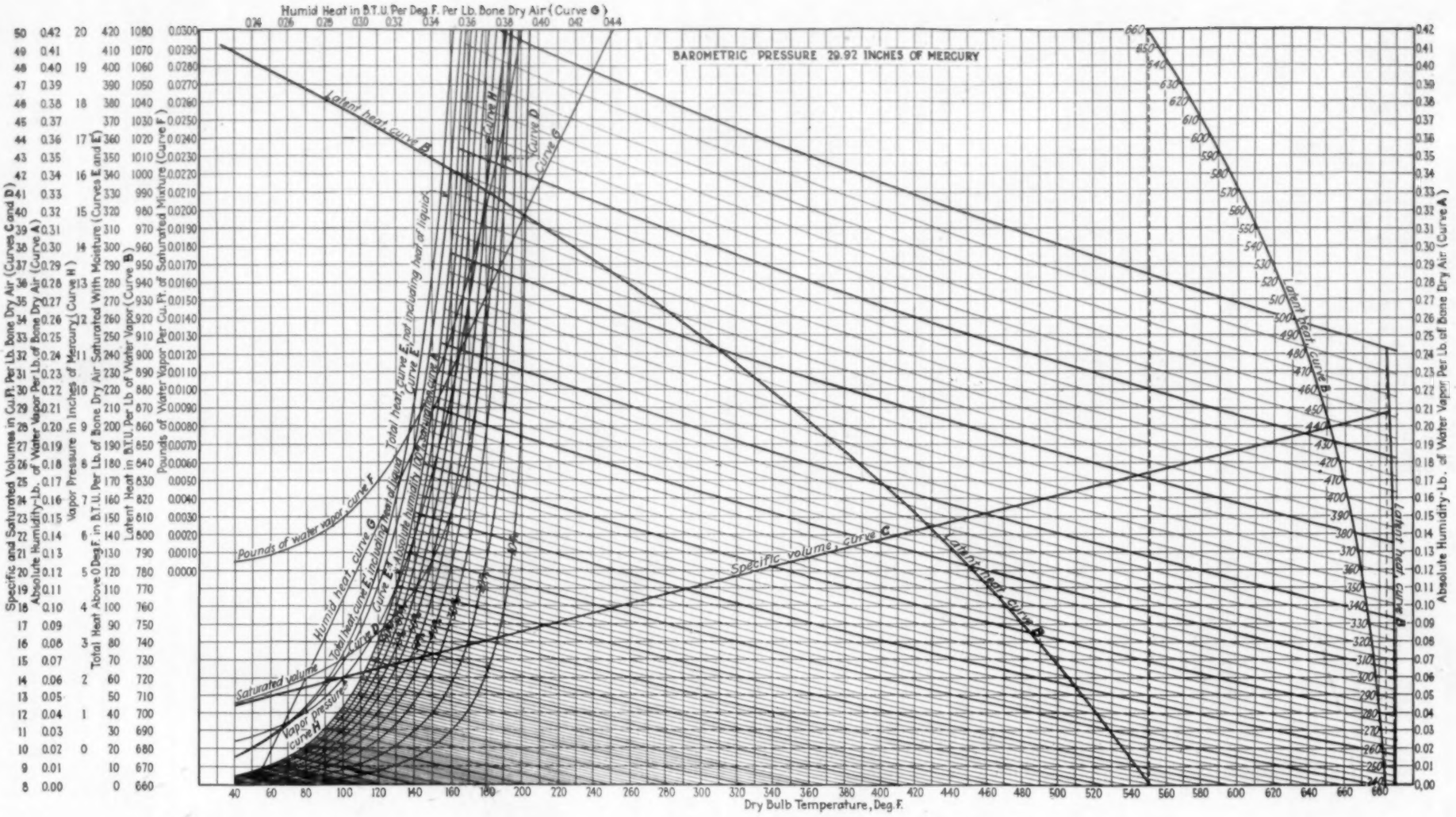
$$s = (0.24112 + 0.000009\,t) + (0.4423 + 0.00018\,t) \times H$$

At 140 deg. F.:

$$s = 0.24238 + 0.4675 \times 0.1515 = 0.3132 \text{ B.t.u.}$$

H—Adiabatic Cooling Lines. It is essential in using a humidity chart to be able to determine the relation between the initial and final conditions of an air mixture undergoing an adiabatic change in temperature and moisture content. (A system is said to have undergone an "adiabatic process" when there is no heat interchange with its surroundings. This condition is very closely approached in process of drying.) For this purpose, there have been constructed a series of lines starting from the absolute humidity curve and extending toward the right. These lines are commonly known as "adiabatic cooling lines."

An unsaturated air-water vapor mixture in contact with water colder than itself will fall in temperature, and


Humid Heat in B.T.U. Per Deg. F. Per Lb. Bone Dry Air (Curve G)
BAROMETRIC PRESSURE 29.92 INCHES OF MERCURY
Specific and Saturated Volumes in Cu.Ft. Per Lb. Bone Dry Air (Curves C and D)
Absolute Humidity-Lb. of Water Vapor Per Lb. of Bone Dry Air (Curve A)
Vapor Pressure in Inches of Mercury (Curve H)
Total Heat Above 0 Deg. F. in B.T.U. Per Lb. of Bone Dry Air Saturated With Moisture (Curves E and E')
Latent Heat in B.T.U. Per Lb. of Water Vapor (Curve B)
Pounds of Water Vapor Per Cu. Ft. of Saturated Mixture (Curve F)
Latent heat, curve B
Curve H
Curve D
Curve G
Total heat, curve E, not including heat of liquid
Curve E
Pounds of water vapor, curve F
Humid heat, curve G
Total heat, curve E', including heat of liquid
Curve E'
Absolute humidity, curve A
Specific volume, curve C
Saturated volume
Vapor pressure, curve H
Dry Bulb Temperature, Deg. F.

A Psychrometric Chart for High Temperature Air Calculations

Curve A.—Absolute Humidity (*H*) as lb. of water vapor per lb. of dry air.

Curve B.—Latent Heat (*r*) as B.t.u. per lb. of water vapor.

Curve C.—Specific Volume (*Sp.V.*) as cu.ft. per lb. of dry air.

Curve D.—Saturated Volume (*Sat.V.*) as cu.ft. of saturated mixture for each pound of dry air.

Curve E.—Total Heat (*T.H.*) above 0 deg. F., neglecting the heat of the liquid, as B.t.u. per lb. of dry air saturated with water vapor.

Curve E'—Total Heat (T_H) above 0 deg. F., including the heat of the liquid, as B.t.u. per lb. of dry air saturated with water vapor.

Curve F.—Weight of Water Vapor (W_V) as lb. per cubic foot of the saturated mixture.

Curve G.—Humid Heat (*s*) as B.t.u. per deg. F. per lb. of dry air.

The lines sloping down to the right are "adiabatic cooling lines" for determining adiabatic changes in air.

under adiabatic conditions the sensible heat so given up by the air mixture will be entirely dissipated in bringing the water to the wet bulb temperature and then in evaporating a certain quantity of the water. If the water is already at the wet bulb temperature, we can formulate a heat balance for such an adiabatic change in water content as follows. Let:

$(T.H.)_1$ = total heat, neglecting the heat of the liquid, of the air mixture in the initial condition.

s_1 = humid heat of the air mixture in the initial condition.

t_1 = temperature in deg. F. of the air mixture in the initial condition.

The air mixture in this initial condition can now be heated without change of water content to a dry bulb temperature t_2 and then adiabatically cooled to a wet bulb temperature t_w. If $(T.H.)_2$ is the heat total of the air mixture, neglecting the heat of the liquid, at the wet bulb temperature, then we may write:

$$(T.H.)_1 + s_1 (t_2 - t_1) = (T.H.)_2$$

which equates a heat balance at any point along an adiabatic cooling line. This last equation can be used in the construction of the adiabatic cooling lines. Rearranging the equation:

$$t_2 = \frac{(T.H.)_2 - (T.H.)_1 + s_1 t_1}{s_1}$$

To illustrate how any particular cooling line is determined from the initial and final conditions of the air mixture using the above equation, construct the cooling line leading to the wet bulb temperature of 140 deg. F. To calculate points on this particular line different initial conditions of an air mixture may be assumed, but in all cases the final condition will be a wet bulb temperature of 140 deg. F. Taking in one case an air mixture initially at a dew point of 90 deg. F. ($H = 0.3072$ lb.), the following values are obtained:

$$(T.H.)_2 = 189.00 \text{ B.t.u.}$$
$$(T.H.)_1 = 54.00 \text{ B.t.u.}$$
$$s_1 = 0.2563 \text{ B.t.u.}$$

therefore

$$t_2 = \frac{189 - 54 + 0.2563\ (90)}{0.2563} = 617 \text{ deg. F.}$$

that is, this particular cooling line intersects an absolute humidity of 0.3072 at 617 deg. F.

If the air mixture initially has a dew point of 110 deg. F. ($H = 0.05862$ lb.), the following values will be used

$$(T.H.)_2 = 189.00 \text{ B.t.u.}$$
$$(T.H.)_1 = 87.00 \text{ B.t.u.}$$
$$s_1 = 0.2692 \text{ B.t.u.}$$

therefore

$$t_2 = \frac{189 - 87 + 0.2692\ (110)}{0.2692} = 490 \text{ deg. F.}$$

that is, this same line intersects an absolute humidity of 0.05862 at 490 deg. F.

Use of the Chart. In a direct contact coal drier, air enters at a dry bulb temperature of 372 deg. F. with a dew point of 75 deg. and leaves the drier with a dry bulb temperature of 140 deg. and a wet bulb temperature of 120 deg. F. Determine the following factors:

1.—The dew point of the exit air.
2.—The humid heat of the entering air.
3.—The vapor pressure of the air saturated at 75 deg. F.
4.—Total heat ($T.H.$) of the exit air.
5.—The specific volume of dry air at 75 deg. F.
6.—The saturated volume of the air saturated at 75 deg. F.
7.—The pounds of water vapor contained in a cubic foot of the exit air.
8.—The latent heat of water vapor at the wet bulb temperature of the exit air.

The solution is obtained as follows:

1. From the chart it is seen that air with a dew point of 75 deg. F. has an absolute humidity of 0.08155 lb. Passing horizontally from the 75 deg. F. point on the "100 per cent" saturation curve *(A)*, the dry bulb temperature of 372 deg. F. is seen to fall on the adiabatic cooling line that leads to a wet bulb temperature of 120 deg. F. Passing along this adiabatic cooling line to a dry bulb temperature of 140 deg. F. and then horizontally to the "100 per cent" saturation curve *(A)*, the dew point is found to be 118 deg. F., which corresponds to an absolute humidity of 0.075 lb. read directly from the absolute humidity scale at the left.

Table of Values Used in Plotting High Temperature Psychrometric Chart

Temp., Deg. F.	Vapor Press. In. of Mercury	Humidity Absolute	Humid Heat, B.t.u.	Latent Heat of Water Vapor, B.t.u.	Volume		Total Heat Above 0 Deg. F.	
					Specific, Cu.Ft.	Saturated, Cu.Ft.	*T. H.* B.t.u.	T_h B.t.u.
32	0.180	0.00376	0.2432	1,071.7	12.377	12.451	11.75	11.87
35	0.206	0.00424	0.2435	1,070.2	12.452	12.537	13.05	13.20
40	0.247	0.00505	0.2438	1,067.5	12.578	12.680	15.30	15.50
45	0.299	0.00626	0.2445	1,065.4	12.704	12.832	17.75	18.03
50	0.360	0.00757	0.2451	1,062.3	12.830	12.986	20.20	20.58
55	0.438	0.00912	0.2460	1,059.6	12.956	13.146	23.00	23.50
60	0.524	0.01094	0.2469	1,057.0	13.082	13.312	26.00	26.66
65	0.624	0.01308	0.2481	1,054.4	13.206	13.484	29.45	30.30
70	0.742	0.01559	0.2491	1,051.8	13.334	13.669	33.50	34.59
75	0.878	0.01855	0.2506	1,049.2	13.458	13.860	37.75	39.14
80	1.022	0.02200	0.2523	1,046.4	13.585	14.066	42.50	44.26
85	1.203	0.02603	0.2541	1,043.9	13.710	14.284	47.90	50.11
90	1.408	0.03072	0.2563	1,041.2	13.838	14.522	54.00	56.77
95	1.645	0.03667	0.2593	1,038.5	13.962	14.774	60.93	64.37
100	1.916	0.04251	0.2616	1,035.7	14.090	15.046	68.70	72.91
105	2.225	0.04997	0.2651	1,032.9	14.216	15.359	77.00	82.25
110	2.579	0.05862	0.2692	1,030.1	14.348	15.702	87.00	93.45
115	2.975	0.06866	0.2740	1,027.3	14.472	16.067	97.00	104.90
120	3.425	0.08040	0.2795	1,024.4	14.595	16.481	112.00	121.65
125	3.898	0.09415	0.2860	1,021.5	14.720	16.948	127.00	138.76
130	4.505	0.11022	0.2936	1,018.7	14.845	17.477	145.00	159.83
135	5.145	0.12927	0.3027	1,015.8	14.970	18.082	164.00	183.24
140	5.861	0.15150	0.3132	1,013.1	15.095	18.775	189.00	210.21
145	6.661	0.17816	0.3259	1,010.1	15.220	19.581	216.00	241.83
150	7.552	0.21005	0.3411	1,007.2	15.350	20.540	250.00	281.51
155	8.542	0.24534	0.3579	1,004.3	15.475	21.585	289.00	327.02
160	9.637	0.29553	0.3818	1,001.4	15.600	23.010	338.00	385.30
165	10.851	0.35286	0.4092	998.4	15.725	24.645	397.00	455.20
170	12.123	0.42756	0.4449	995.5	15.852	26.742	471.00	543.67
175	14.583	0.52285	0.4904	992.7	15.976	29.416	567.00	658.50
180	15.285	0.64942	0.5510	989.4	16.102	32.892	694.00	810.85
185	17.062	0.82430	0.6348	986.5	16.130	37.660	869.00	1,021.50
190	19.000	1.00805	0.7232	983.3	16.355	42.875	1,127.00	1,318.70
195	21.132	1.49940	0.9585	980.3	16.480	56.180	1,590.00	1,882.40
200	23.440	2.26800	1.3277	977.2	16.610	77.130	2,293.00	2,746.60
205	25.990	4.22720	2.2686	974.1	16.732	.....	.....	.....
210	28.740	15.81740	7.8368	970.9	16.865	.....	.....	.....

Supplementary Table for High Temperature Range

Temp., Deg. F.	Latent Heat of Water Vapor, B.t.u.	Specific Volume, Cu.Ft.	Temp., Deg. F.	Latent Heat of Water Vapor, B.t.u.	Specific Volume, Cu.Ft.
220	964.7	17.114	480	747.9	23.666
240	951.4	17.618	500	725.5	24.170
260	937.7	18.122	520	700.0	24.674
280	923.6	18.626	540	673.9	25.178
300	908.7	19.130	560	644.3	25.682
320	893.7	19.634	580	611.0	26.186
340	877.1	20.138	600	573.2	26.691
360	861.7	20.642	620	529.4	27.194
380	845.1	21.146	640	476.0	27.698
400	827.9	21.650	660	403.9	28.202
420	810.0	22.154	680	280.6	28.706
440	790.3	22.658	689	000.0	28.903
460	769.8	23.162	700	000.0	29.210

Curve D.—Saturated Volume (*Sat.V.*) as cu.ft. of dry air.
dry air saturated with water vapor.
in air.

2. The humid heat of the entering air is obtained by passing horizontally from the 75 deg. F. reading on the "100 per cent" saturation curve (*A*) to the humid heat curve (*G*) and read directly from the scale at the top of the chart as 0.2506 B.t.u.

3. The vapor pressure of the air saturated at 75 deg. F. is obtained from the intersection of the 75 deg. F. temperature line with the vapor pressure curve (*H*), being read directly on the corresponding scale at the left as 0.878 in. of mercury.

4. The total heat (*T.H.*) of the exit air is obtained from the intersection of the 118 deg. F. temperature line with a curve of total heat (*E*), being read on the corresponding scale at the left as 105.5 B.t.u.

5. The specific volume of the dry air at 75 deg. F. is obtained from the intersection of the 75 deg. F. temperature line with a curve of specific volume (*C*), being read directly on the corresponding scale at the left as 13.44 cu.ft.

6. The saturated volume is found in the same manner as in (5) from the intersection with the saturated volume curve (*D*).

7. The weight of water vapor in lb. per cu.ft. of the exit air is obtained from the intersection of the 118 deg. F. line (dew point of exit air) with the curve (*F*) and read directly from the corresponding scale at the left as 0.0466.

8. The latent heat of the water vapor at the wet bulb temperature of the exit air (120 deg. F.) is obtained from the intersection of the 120 deg. F. line with the latent heat curve (*B*) and read directly from its corresponding scale as 1024.4 B.t.u.

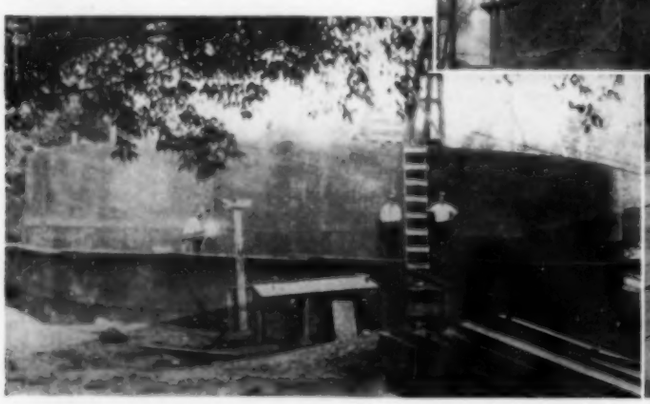
Gas Holder Built Entirely by Arc Welding

WHAT is believed to be the largest all electric arc welded low-pressure gas holder ever built has just been completed at Albion, Michigan. The construction and design are both the work of the Western Gas Construction Company, of Fort Wayne, Indiana, and it is from the vice-president of that company, F. H. Beebe, that details of the holder are available. The holder with all lifts elevated to their maximum height stands 113 ft. 7 in. above the foundation. It has a diameter of 74 ft. and weighs 516,385 lb. plus the weight of the welding rod that was used. The gas holder has a capacity of 300,000 cu.ft. of gas at a water pressure, when full, of 12 in. The finished holder appears in the upper illustration, complete with its 21,414 lineal ft. of welding, placed with the four Lincoln Electric Company "Stable-Arc" welders which were used in the construction.

With the exception of a small 15,000 cu.ft. holder at Lexington, Missouri, the one at Albion is the only low pressure holder built entirely by arc welding. Welded joints have proved perfectly satisfactory in structural strength and are gas and water tight. The latter fact points to one of the great advantages in using electric welding for gas holders. In addition, welding simplifies construction and reduces fabricating cost. When a gas holder is made of riveted plates it is necessary to employ the tank shop to lay out and punch all the members. When metallic arc welding is used it is only necessary to lay out and punch the holes for fitting-up bolts. The plates were, of course, rolled to the proper radii in the shops. Only the cups and grips were fabricated apart from the job. It has been found that there is so much to recommend the use of welding that it will almost inevitably find universal adoption for the fabrication of pressure vessels of every type.

The bottom and first course of the holder were built on a foundation three ft. below the yard level. Water, permitted to stand in a pit around the foundation, served as a test for leaks in the bottom and lower curb, and it is interesting to know that none were found. The illustration at the lower left shows the gas holder at the time of completion of the water tank. When the photograph was taken the final welding was in process. The joints were of the lap type, easy to weld and contributed to the simplicity of construction which characterized the job throughout.

At the lower left is shown the crown of the upper section in process of being laid. A wooden understructure was built on which the plates were located. They were laid in circular overlapping rows from the outside to the center, tack welded and finally finish welded.



At the Left is the Water Tank with the Last Seams Being Welded. Above is the Finished Holder. At the Right the Crown of the Upper Section Appears Under Construction

Modified Circulation System Improves Operation of Chamber Plant

By E. L. Larison
Anaconda Copper Mining Company, Anaconda, Mont.

IT IS a well recognized fact that in the process of absorption of gases by liquids in packed towers, efficiency varies with completeness of wetting of the packing. If a changing and moving film of the absorbing liquid be maintained on every surface of the packing, maximum absorption is obtained. If there are dry channels, or portions of the packing in which the liquid film is not constantly renewed, absorption below maximum results.

In a chamber plant as ordinarily operated, the volume of acid distributed over each Gay Lussac tower is the same as that of the nitrous vitriol fed to the Glover tower. The latter is in turn, limited by the concentrating capacity of the Glover, since the more nitrous vitriol fed, the less chamber acid can be concentrated. Moreover with variation of chamber conditions there is ordinarily variation in the volume of nitrous vitriol fed, and this variation is reflected back to the Gay Lussacs. Often the volume of nitrous vitriol which can be fed to the Glover is less than the amount most desirable for distributing on the Gay Lussacs.

At a plant under my supervision a simple change in operating detail was made about two years ago, which has obviated the undesirable condition described above and has resulted in a very marked nitre economy.

Distribution on the Gay Lussac towers was made through splash plates as shown in Fig. 1. The distributor orifices, in the splash plates are made of such size as to be always full and in consequence to always spread the acid well. The distributor used as shown is easily kept clean by lifting the cap and inserting a rod of about the size of the nozzle. It can also be easily replaced without tools in a few minutes. The nozzle orifice is large enough to accommodate the greatest flow ever wanted and when running to capacity the distribution was excellent. More often than not however, the volume of acid was less than the nozzle's capacity, the velocity of the jet issuing was low, and the distribution far from perfect.

Fig. 1—Acid Distributor

In order to obtain a constant and ever-sufficient flow on these towers, such a flow was set and left undisturbed. This was more by 50 per cent than the amount of nitrous vitriol taken by the Glover. Consequently the tank receiving acid from the No. 1 Gay Lussac overflowed, and the overflow was carried back to the No. 2 tower receiving tank. The No. 2 tank likewise overflowed back to the No. 3 and the No. 3 to the Glover receiving tank. In this way a circulating load of acid was maintained on each tower and the actual total volume of acid circulated was constant and as large as desired. This flow is shown in Fig. 2, and the arrangement of tanks and launders necessary for bringing it about is given in Fig. 3.

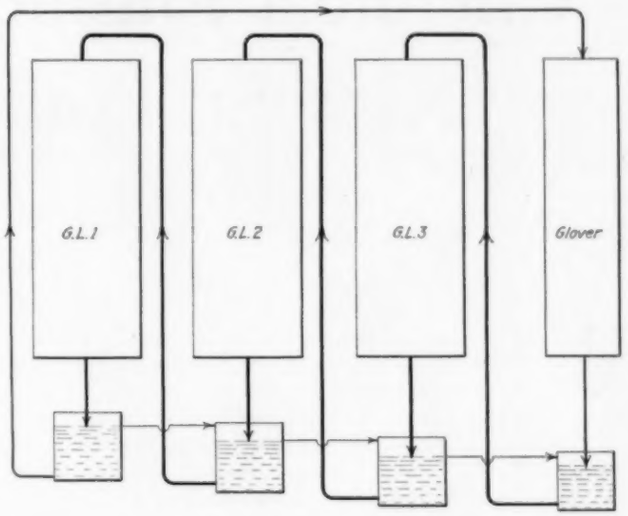


Fig. 2—Acid Circulating System

The results of this change described are shown below:

Daily production .....130 tons 60 deg. acid
Horizontal cross section G.L. tower..... 200 sq.ft.

	Former Practice	New Practice
Nitrous Vitriol per 24 hrs., tons.....	240	240
Acid to each Gay Lussac per 24 hrs., tons.	240	400
Circulating load, tons.....	None	160
Total nitre in terms of $NaNO_3$ introduced to Glover per 24 hrs., lb.....	16,200	16,200
New $NaNO_3$ per 24 hrs., lb.....	2,500	1,700
Per cent recovery in Gay Lussacs.....	85	90
Per cent new $NaNO_3$ on S in acid.....	3.75	2.5

A further development of this plan permits one to decrease the volume of nitrous vitriol fed to the Glover tower to very small quantities and as a result considerably increase the concentrating ability of the Glover. This can be used to increase the amount of 60 deg. acid made from chamber acid or to make acid of higher strength, even up to 66 deg.

The operating plan and the distributor shown are the subjects of letters patent, numbers 1,613,139 and 1,638,042.

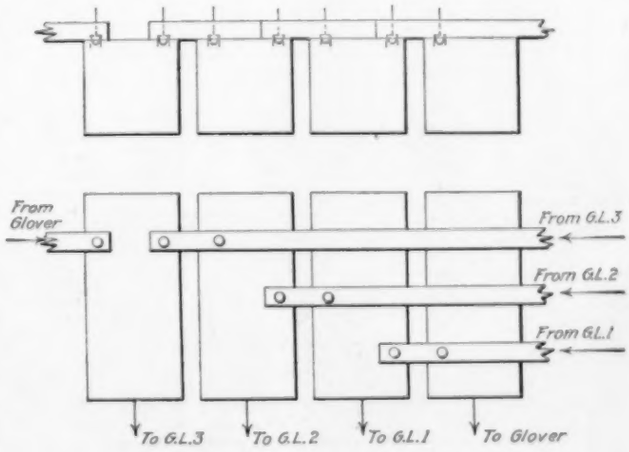


Fig. 3—Arrangement of Tanks and Launders

Chemical Engineering Applied in New St. Louis Water Plant

By Charles W. Cuno
Consulting Chemical and Metallurgical Engineer, St. Louis, Mo.

WHILE the construction of water works for cities has always been a major engineering problem, the entrance of chemical engineering into its own has never been more apparent than at the new plant of the St. Louis water service now being completed at Howard Bend on the Missouri River. Procuring potable water for the citizens of St. Louis involves additional difficulties due to the pollution of the Mississippi water from the upper river and the muddy nature of the water from the Missouri. This condition has been aggravated in recent years by the fact that Chicago discharges its sewage into the Illinois River, and this flows into the Mississippi about 30 miles above St. Louis.

At the Chain-of-Rocks plant located on the Mississippi, about ten miles north of the city, perhaps more is done to the raw water than at any other American city. The water is first treated with milk of lime and then with ferrous sulphate. After passing through six settling basins it is treated with aluminum sulphate and filtered. Finally, just before it enters the mains it is treated with chlorine. In summer when algae and other diatomaceous organisms grow very rapidly in the reservoir basins the water is also treated with copper sulphate.

This plant, which delivers upwards of 46 billion gallons per year is rapidly becoming inadequate for the growing needs of the city. A new plant is therefore being erected at Howard Bend on the "Big Muddy." At the present plant a great difference is noted between water taken from the west intake, which is mostly Missouri River water, and that of the east intake, which contains considerable water from the Illinois River. The Missouri River water is very muddy, but when freed from suspended matter, comparatively clean, while the east-intake water is much clearer, but contains considerable color and colloidal matter which is very difficult to remove.

The first radical innovation at Howard Bend is that the intake and pump house are located directly on the shore of the river. Dikes and revetments will keep the channel of the river against the intake. The water flows through travelling screens directly to low pressure pumps located in a pit just a few feet from the intake gates and some forty feet below the high water mark of the river. After purification the water flows back to the pump house again and is forced by the high pressure pumps through a 5-ft. steel main to various reservoirs on its eighteen-mile trip to St. Louis.

Coming back to our raw water, the low pressure pumps discharge this into two primary Dorr clarifiers each 150 ft. square with a working capacity of 2,500,000 gal. The velocity through these clarifiers will be 1½ ft. per min., with a detention period of two hours and ten minutes on a rated capacity of 55,000,000 gal. daily. Although the turbidity of the raw water entering these clarifiers will sometimes be greater than 10,000 parts per million, it is expected that the effluent from the clarifiers will rarely exceed 500. It should be emphasized that up to this point the water will receive no chemical treatment.

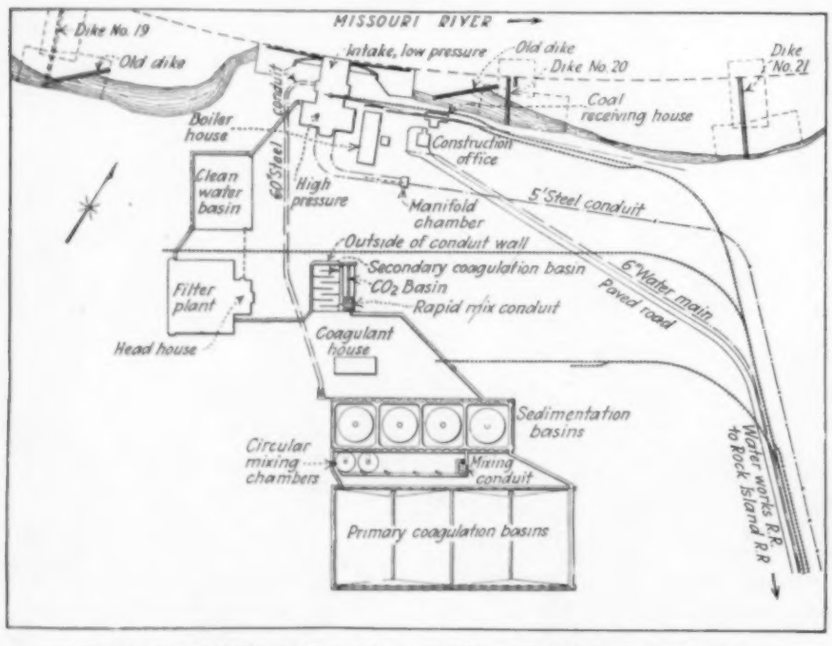


Fig. 1—General Plan of New St. Louis Water Works at Howard Bend

The water leaving these clarifiers will pass into an S-shaped mixing conduit of six compartments having five 180-deg. rounded turns. The over-all length of the conduit is 170 ft., and the velocity of water flow will be 1.55 ft. per second. Milk of lime, prepared in the coagulant house, will be added as the water enters the conduit, and sulphate of iron as it leaves. From the mixing conduit the water will be introduced tangentially at the top of circular mixing tanks 65 ft. in diameter and withdrawn at the center bottom. The object of this is to produce the proper iron hydroxide-calcium carbonate flock for the settling basins.

From the tangential mixing tanks the water will flow to secondary Dorr clari-

fiers of the same size and type as the primary ones already described, and from thence to coagulation or settling basins each 406x330 ft., having a working capacity of 15,000,000 gal. The velocity through these basins will be 0.396 ft. per minute and the detention period will be thirteen hours. It is expected that the turbidity of the water leaving these basins will not exceed five parts per million. From the coagulating basins the water flows to the carbon dioxide chamber, 110 ft. long, 41 ft. wide and 18 ft. deep, with a center baffle, the rate of flow being 15.6 ft. per min. and the detention period 14 minutes. The carbon dioxide will be obtained from the boiler-house flue gas, burning bituminous coal. The water will then flow through a second rapid mixing chamber similar to the one already described, the proper amount of aluminum sulphate being added as the water enters the conduit, and from thence through a secondary coagulation chamber 90 ft. long and 159 ft. wide, with seven baffles, making the channels 19 ft. wide. In the above the aluminum sulphate will be thoroughly mixed with the water in the mixing conduit and the slower flow in the baffled chamber will produce a maximum flock of aluminum hydroxide for the subsequent filtering process.

The water leaving the secondary coagulation basin will pass to twenty filters, each having a capacity of 4,000,000 gal. per day. These filters are of the newest design, having eighteen inches of graded gravel and twenty inches of sand upon which the aluminum hydroxide flock settles, and form an effective filter medium for the purpose of entangling any residual turbidity, color and bacteria remaining in the water. They are of the automatic washing type, similar to that used in the old plant, but of improved design. Chlorine will be added to the effluent to take care of any bacteria that may have escaped the filter. The first settling operation entangles from 90 to 97 per cent of the bacteria, and the filter bed approximately 90 per cent of the remainder, but at the present plant the Mississippi River water averages 18,500 bacteria per c.c. and at certain times runs up above 50,000. In the latter case this would mean that some 500 bacteria per c.c. were still present, while after treatment with chlorine the average number is less than 10 per c.c. The chlorine is to be measured by a Wallace-Tiernan pedestal type machine, the cylinders being placed on a chloro-scale which will record the amount of chlorine being used.

All of the chemicals will be prepared in a centrally located coagulant house as shown in Fig. 1 and will flow by gravity to the mixing conduits. The chemicals will be weighed on Richardson scales which will dump at set periods onto a moving belt. The speed of the belt and the time of dumping will be so controlled that a steady stream of coagulant will be fed into the dissolving boxes.

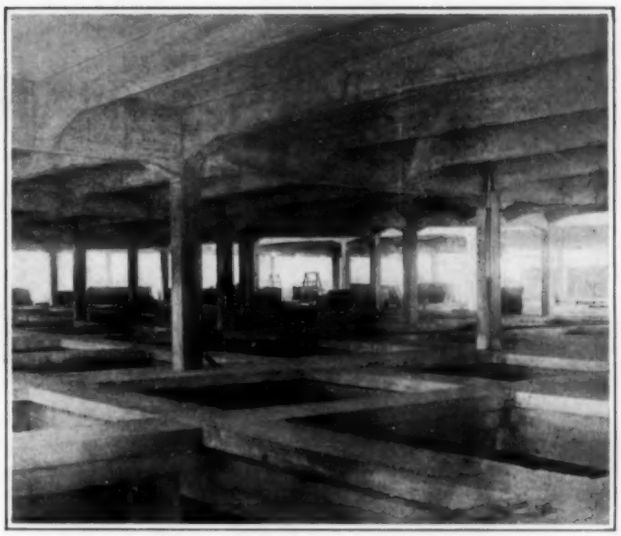


Fig. 2—Interior View of Filter House

All chemicals will be unloaded and placed in storage by means of air.

The amount of chemicals added to the water varies, of course, with the dissolved solids in the water and a very careful daily analysis is made of turbidity, dissolved solids and bacteria content. A general idea of the quantity of chemicals added may be obtained from the average amounts used for the past year at the Chain-of-Rocks plant, which is as follows:

Lime	4.816 grains per gal.
Ferrous sulphate	0.927 grains per gal.
Aluminum sulphate	1.413 grains per gal.
Chlorine	4.281 lb. per million gal.

It is confidently predicted that, owing to the nature of the water from the Missouri River and the preliminary clarification with Dorr clarifiers, the amount of chemicals used at the new plant will be considerably less.

The following are some figures from the present plant: From approximately 47 billion gallons of raw water, 222,694 tons of suspended matter and 16,121 tons of dissolved solids are removed in the process of purification. The average river water contained last year 1,080 parts of suspended solids, 28 parts of colloidal color and 282 parts of dissolved solids per million; its carbonate hardness was 124 and sulphate hardness 44. In purification all of the suspended solids, 17 parts of the colloidal color and 83 parts of dissolved solids were removed. The carbonate hardness was reduced from 124 to 49 and the sulphate hardness increased from 44 to 56, a net decrease of 63.

Fig. 3—New Filter House Under Construction

Special Motors Reduce Hazards in Explosive Atmospheres

By R. H. Rogers
Industrial Engineering Department,
General Electric Company

THERE was a time in the chemical engineering industries when almost anything would do, when hazards were overlooked, when equipment was make-shift, profits were large, and "make production" was the only watchword. This time has passed and the increasing complexity of both products and competition has ushered in an era of safety, to relegate slipshod methods to the scrap heap. The initiative in some cases has been taken by Governmental or local authorities, while in others it has been the prerogative of the industrialists or their societies.

It is increasingly apparent that safety demands special motors for such types of service. In the application of electrical apparatus in mines, a high degree of hazard is assumed to exist because of the possibility of fire from ignition of gases and the serious consequences to workmen trapped underground. For this work the United States Bureau of Mines some time ago set up standards for permissible apparatus. The Bureau does not, however, claim any jurisdiction over apparatus for industrial plants, and consequently, unless local regulations require special motors, the user is placed on his own responsibility.

Where motors are certain to operate continuously in explosive atmospheres, it is obvious that the open direct current motor, or wound rotor induction motor cannot be used on account of exposed sparking at commutators and the collector rings. Such atmospheres are those in which a flammable gas or vapor is mixed in dangerous proportions with air. However, the open squirrel-cage motor is ordinarily considered fairly safe, especially for the less hazardous conditions. It is desirable to have this type of motor equipped with special insulation and a shelter top to protect the motor against injury by dropping objects. These features add to the factor of safety, and with proper care of the windings and bearings there is little possibility of sparks originating in the motor. For the more hazardous conditions even the squirrel-cage machine should be considered only in special constructions.

The ordinary totally inclosed motor, as designed by practically all manufacturers, is not gas tight. Such motors, nevertheless, when well constructed, are ordinarily quite safe for use in atmospheres where the explosive hazards consist of air-borne dust and when flammable gases and vapors are absent. Where, however, gas is continually present this type of machine is not recommended. Undoubtedly, there are plants where ordinary totally inclosed motors of the commutator or slip ring type are practically as safe as the open squirrel-cage motor. These are plants where the gases only occasionally or accidentally come in contact with the motor and the atmosphere is rapidly cleared

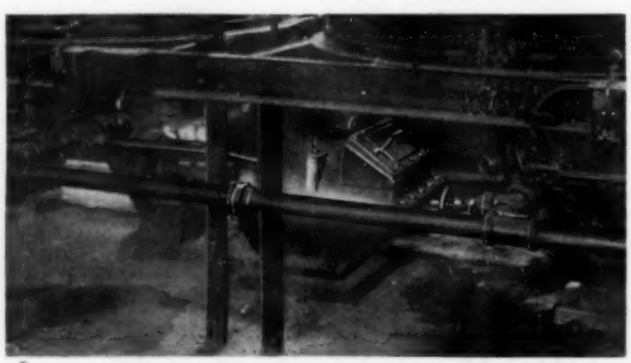


Fig. 1—Motor with Wide Flange Inclosing Case Installed in a Varnish Plant

Fig. 2—Inclosing Case with Wide Flange Construction

Fig. 3—Fan-Cooled Totally Inclosed Motor Available in Larger Sizes

Fig. 4—Constant-Speed Totally Inclosed Motor with Starter

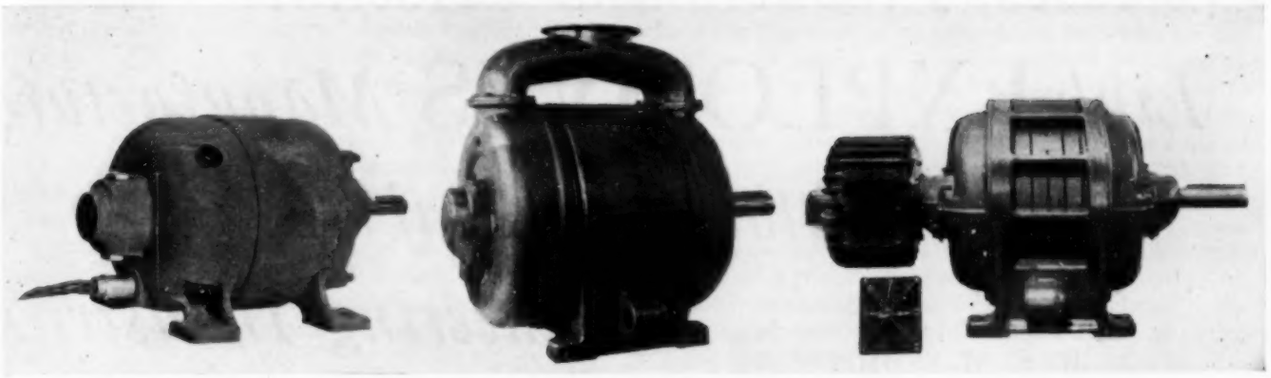


Fig. 5—Fractional-Horsepower Motor with Wide Flanges

Fig. 6—Inclosed, Ventilated Induction Motor Available in Moderate Sizes

Fig. 7—Wound Rotor Induction Motor Available in the Larger Sizes

by the ventilating system. For these cases, the ordinary enclosing features would prevent immediate direct contact of the gases with the sparking surfaces. However, if the gas were to remain for any length of time, it would undoubtedly reach the commutator or slip rings. The new totally inclosed fan-cooled motors, for both alternating and direct current are practically dust tight, but are not gas-tight and therefore come in practically the same classification as other ordinary totally inclosed machines, not especially designed for use in explosive gases.

A special totally inclosed motor, designed particularly for use in explosive gases in accordance with the recommendations and requirements of the Bureau of Mines and the Underwriters' Laboratories, will generally embody "wide flange" construction. This construction involves the use of inclosing parts heavy enough to withstand the pressures of internal explosions and the use of carefully machined flanged joints sufficiently wide to cool the flame of an internal explosion down to a point where it will not ignite the surrounding gas. No gaskets may be used, as these might be damaged or even omitted during reassembly of such apparatus. In motors of 1 hp. and larger sizes, a flange at least 1 in. wide is usually required. The joints must be fitted with a sufficient number of bolts to prevent warping or buckling of the flanges between bolts during an explosion. Such motors are not gas-tight and gas may consequently be breathed into the housing while it is cooling after an extended run under load. As pointed out, however, an explosion of this gas inside the motor will not transmit flame to the outside of the machine if the proper type of construction is used.

Several types of motors have been designed and built using this construction and are now available. One such motor installed in a varnish plant is shown in Fig. 1. The motor appears again in Fig. 2. The safety feature is embodied in the case itself, which obviously can be used to house induction motors, single-phase motors, or direct-current motors. This construction is available in sizes not greater than 15 hp.

Fig. 3 illustrates a wide flange construction used with a totally inclosed motor of the fan-cooled type. While the ordinary totally inclosed fan-cooled motor is not recommended for use in explosive gases, a motor of this type modified to use wide flanges, heavy inclosing features, a sufficient number of bolts and the proper terminal plates, as illustrated, can be furnished in larger sizes.

Direct-current, constant-speed, totally inclosed motors with starters built in accordance with the requirements of the U. S. Bureau of Mines for equipment permissible for use in gaseous mines have been developed in ratings from 1 to 5 hp. for 1,200 r.p.m. and 250 volts. This construction is illustrated in Fig. 4. Fractional horsepower motors with wide flange construction, rated at $\frac{1}{4}$, $\frac{1}{3}$ and $\frac{1}{2}$ hp., have been designed and are illustrated in Fig. 5. Any of these latter motors are suitable for light service in explosive atmospheres.

The inclosed, ventilated motors illustrated in Fig. 6 are available in polyphase and direct-current types in the usual ratings. This type of machine is considered fairly safe for use in explosive gases, provided, of course, that the intake and outlet joints are kept in a tight condition and a supply of fresh air is constantly maintained. In very hazardous locations, it is advisable to provide an auxiliary fan to force air to the motor whether it is operating or not. Another style available in the larger sizes is the wound rotor induction motor with outside inclosed collector rings, as shown in Fig. 7.

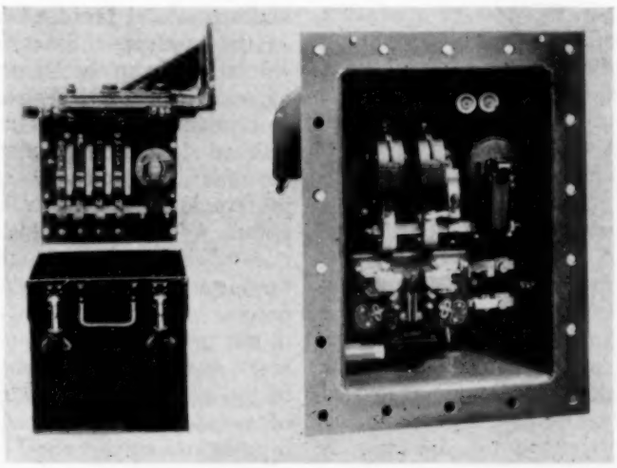


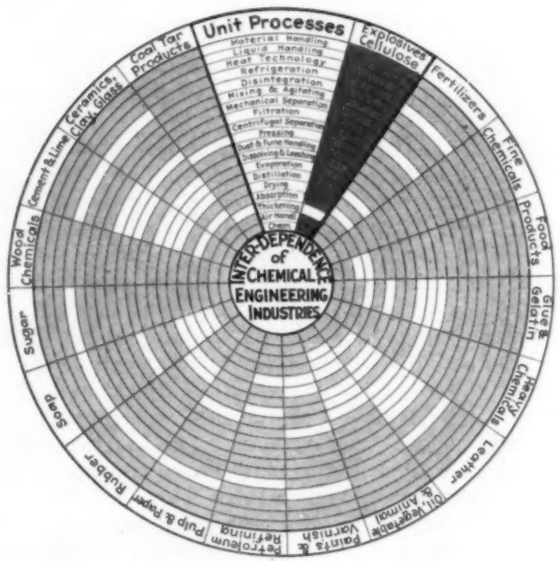
Fig. 8—Starter Approved for Use in Gaseous Mines

Fig. 9—Oil-Immersed Magnetic Switch

Finally, a word should be said about control devices. Where such equipment would cause exposed sparking, it is obviously not recommended for use in explosive atmospheres. It becomes necessary (a) to locate the control in a separate, well-ventilated room; (b) to inclose all contact-making parts in special inclosed cases; or (c) to immerse all contacts in oil and exercise great care to maintain the oil at the proper level. Such a control as is specified in (b) was shown in Fig. 4 and is illustrated more fully in Fig. 8. A magnetic switch which fulfills the last requirement is indicated in Fig. 9. These devices together with the proper motors, as previously described, should eliminate explosion hazards from motor sources.

Processes, Products and Personnel Link EXPLOSIVES *Manufacture to Other Chemical Engineering Industries*

By E. M. Symmes
Hercules Powder Company, Wilmington, Del.



UNFORTUNATELY—or fortunately, depending upon the point of view—the explosive maker has no recourse to such marketing campaigns as "Use More Explosive Week," or "A Cartridge a Day Keeps the Doctor Away." On the contrary, he devotes considerable effort and ingenuity in the education of his customers to use *less* explosive, because the business goes to the producer who can show the lowest figure for explosives cost per ton of product on the cost sheets of his customers. In general, therefore, the demand for explosives in normal times is reasonably constant, so that the producers of explosives, seeking expansion, have generally turned to the many related industries based on the use of the same raw materials and many of the same chemical engineering processes. This discussion, however, will be limited to the main trunk of this flourishing family tree, namely, the production of industrial explosives.

Dynamite, the commonest industrial explosive, is a mixture of nitroglycerine and "dope," the latter ubiquitous appelation applying in this case to a mixture of an oxidizing salt, such as Chile saltpeter or ammonium nitrate, and a carbonaceous material such as wood meal, starch, flour, vetegable ivory, oat hulls, and the like. "Nitroglycerine" too, as the word is used in the dynamite plant, is a generic name and may include true nitroglycerine or mixtures of it with nitrated glycol, nitropolyglycerine or nitrosugar.

Glycerine is nitrated by running it into a nitrator containing mixed acid kept at 42 to 45 deg. C. by means of brine coils. The mixture is run to a shallow tank and allowed to stand for about 30 minutes when the N.G. floats to the surface, is drained off into warm wash water and is further washed with warm soda ash solution. The finished N.G. is stored and made into dynamite as needed by mixing it with dope, this blending operation requiring only about 5 minutes, and afterward the dynamite is packed by machines into paper shells which are waterproofed by dipping into molten paraffin. Gelatin dynamite, which has a doughy consistency and is water resistant, differs only by the addition of one per cent or less of high viscosity nitrocellulose to the N.G. before adding the dope, which causes the mass to gelatinize, in which state it can be extruded into the usual paper cartridges.

This outline of the manufacturing method gives an insight into the unit processes which find application there. Material handling, for example, is an important and specialized process because of the capricious nature of the products. Safety is necessarily the prime consideration, from the laying out of the plant in a number of small isolated units requiring the attendance of not more than two men as a rule, to the handling of the finished dynamite by hand trucks; which are adequate for the comparatively small quantities handled and preferable to automatic devices from the safety standpoint. Wood, hard rubber and lead are common materials of construction for the handling of ingredients and products. Refrigeration has been mentioned as a vital process during nitration. Disintegration is illustrated in the grinding of dope materials such as sulphur, saltpeter, coal or other carbonaceous ingredients. Mixing of the N.G. with dope is generally done in edge runners of wood lined with hard rubber, although the newer installations employ the Talley mixer, a sort of elongated bathtub containing two worm-screw mixers. Mechanical separation is employed in the brush screening of dope to remove foreign matter. Drying is another unit process applied in the preparation of all the ingredients of dope, while evaporation and crystallization are illustrated in the making of ammonium nitrate.

Ammonium nitrate is increasingly important as a constituent of dynamite. Most of the dynamite now produced in the United States is of the ammonium nitrate type, the salt comprising 23 to 24 per cent of the total ingredients. Because it gives a cheaper explosive, and

up to 80 per cent ammonium nitrate, can be incorporated, there is a tendency to use more of the salt and less nitroglycerine.

The velocity of detonation of ammonia dynamite is somewhat less than that of nitroglycerine dynamites. The lower velocity of detonation of dynamites which contain substantial proportions of ammonium nitrate is an advantage, in many cases, since they lift the burden in pieces of a size easier to handle, rather than shatter the surrounding material to dust, as do high velocity dynamites. Such shattering is a useless consumption of energy. Thus, ammonia dynamite offers a double economy—its original cost and its more effective performance.

One of the largest uses of ammonium nitrate is in "permissibles," where it is used in large proportions to cool the explosion to a point where the explosion flame will not ignite the gas and dust in a mine. This is because the temperature of explosion of ammonium nitrate, if initiated by nitroglycerin, is much lower than with other common explosives.

FOR several years, dynamite manufacturers have been striving for a larger number of cartridges per 100 lb., in other words, for a reduction in the density of their dynamites. Starting at 270 cartridges per 100 lb. as a standard permissible about ten years ago, when ground wood pulp was used in the dope, the density has been gradually decreased by substituting chemical pulp, fluffed sawdust, shredded bagasse and lately balsa, until now 500 cartridges per 100 lb. of dynamite are made. Cartridges of this dynamite are selling in direct competition with black powder, heretofore the least expensive explosive, and is also a permissible explosive for underground work. This low density dynamite eliminates the need for the usual air space employed with "cushioned blasting," and reduces the shattering effect on the coal. This race for more cartridges per 100 lb. of explosives has drawn forth considerable technical ingenuity in overcoming troubles with insensitiveness to detonation and hardening during hot weather.

Freezing was formerly the bête noir of the dynamite business. The nitrated polyglycerines were the mainstay of the so-called low-freezing dynamites, about 23 per cent being used for this purpose in the N.G. Dinitrotoluol and trinitrotoluol were also frequently added to lower the freezing point. The advent of ethylene glycol has eliminated the freezing problem, 25 per cent of nitroglycol serving to prevent freezing even in the coldest weather, while it is just as powerful as straight nitroglycerine. (See *Chem. & Met.*, vol. 34, No. 5, p. 296.)

Ethylene glycol has thus become an important ingredient of dynamite since its production on a commercial scale; 9,000,000 lb. is probably a fair approximate figure for the glycol used in dynamite last year. This is a striking illustration of the interdependence of two chemical industries. Equally intimate is the relationship of the soap industry, which supplies 98.5 or 99 per cent glycerine to the dynamite plants. The dynamite maker also patronizes the petroleum industry for the vaseline used to coat the crystals of ammonium nitrate in some grades of dynamite and the paraffin in which his cartridges are dipped; the food products industries for oat hulls, flour, starch, sugar and other carbonaceous constituents of dopes; and the pulp and paper industry for wood pulp and the paper used for cartridge shells and box lining.

Nitric and sulphuric acids are, of course, primary and fundamental raw materials in the manufacture of explosives. The introduction of commercial processes for the production of nitric acid by the oxidation of ammonia is therefore of vital interest and economic significance to the explosives industry. Ammonia oxidation is rapidly releasing the industry from its dependence on Chilean nitrate. Not only does this new source of acid shut down the retorts of the nitric acid plant but it eliminates the large losses of sulphuric acid formerly tapped off with the niter-cake. Thus, the explosive manufacturer will eventually require only enough sulphuric acid to replace the minor losses in the washing after nitration, the denitration of spent acid and the concentration of recovered sulphuric acid.

SINCE smokeless powder, cordite and other nitrocellulose explosives are of small industrial importance it is hardly within the province of this article to discuss developments in the manufacture of soluble nitrocotton which is of such vital importance to the manufacturers of lacquers, coated fabrics, plastics and rayon. Mention may be made, however, of the development of low-viscosity and alcohol-soluble nitrocottons. These desirable properties, imparted to nitrocotton by a six- to eight-hour period of digestion in water represent one of the chemical engineer's important contributions to the manufacture of the varied products using nitrocellulose as a raw material.

Other varieties of nitrocotton, of higher viscosities, are made for artificial leather coatings, celluloid, and a very high viscosity nitrocotton, soluble in nitroglycerin, for use in gelatin dynamites. The alcohol-soluble type finds use in canned heat preparations.

The most recent development in the manufacture of black powder is its fabrication in pellet form, a step accomplished by the simple compression of the usual powder into a more convenient form for loading boreholes. The adoption of black powder pellets by users of this explosive has decreased the hazard attached to the familiar powder keg and the handling of loose black powder.

DETONATOR manufacture involves a specialized technology to which the chemical engineer has contributed liberally. The standard detonator is an 80:20 mixture of fulminate of mercury and chlorate of potash. Tetryl, picric acid and TNT are also used instead of some of the fulminate. In view of the steadily rising cost of mercury, imported from Spain, it is not unlikely that the explosives chemist will be called upon in the near future to provide a substitute for fulminate of mercury.

The explosives industry is manned to a large extent by chemical engineers, to whom it is indebted for the sound technical basis on which it operates at present and in whom its confidence is placed for the future. In general, the explosives maker chooses to develop his technical men from young graduates with chemical engineering training. So broad are the ramifications of the industry and so close its contacts with other chemical engineering industries that many men trained in the dynamite and nitrocellulose business gravitate naturally to the technical departments of coal and metal mining companies, quarry operators, paint and lacquer mills, dye works, solvent producers, and heavy and fine chemical industries of all kinds—evidence that personnel, as well as processes and products, forms a tie that binds the explosive industry to the other members of the process family.

READERS' VIEWS AND COMMENTS

An Open Forum

The editors invite discussion of articles and editorials or other topics of interest

Recognition of Gibbs by Chicago Chemists

To the Editor of Chem. & Met.:

Sir—Your very able editorial in the March issue of *Chemical & Metallurgical Engineering* commented on the important part played by the American chemist, Willard Gibbs, in not only American chemistry but in chemistry in general, and the failure of American chemists to recognize him in any outstanding way. I wonder if you know that the Chicago Section has for seventeen years been awarding each year a Willard Gibbs medal of gold to the chemist who is judged by a jury of twelve notable chemists in this country to have made the greatest contribution to chemistry. The following is a list of those who have been granted this award up to the present:

Svante Arrhenius, Stockholm, Sweden, May, 1911.
Theodore W. Richards, Harvard University, May, 1912.
Leo H. Baekeland, Yonkers, N. Y., May 1913.
Ira Remsen, Johns Hopkins University, May, 1914.
Arthur A. Noyes, Massachusetts Institute of Technology, April, 1915.
Willis R. Whitney, Director, Research Laboratories, General Electric Company, Schenectady, N. Y., May, 1916.
Edward W. Morley, Former Professor Emeritus in Chemistry, Western Reserve University, Cleveland, Ohio, May, 1917.
William M. Burton, Ph.D., Former President, Standard Oil Company, Indiana, May, 1918.
William A. Noyes, Former Chairman of Department of Chemistry, University of Illinois, September, 1919.
F. G. Cottrell, Director of the U. S. Bureau of Mines, May, 1920.
Mme. Marie Sklodowska Curie of the Curie Institute, College de France, June, 1921.
Julius Steiglitz, Chairman, Department of Chemistry, University of Chicago, May, 1923.
Gilbert N. Lewis, Chairman, Department of Chemistry, University of California, April, 1924.
Moses Gomberg, Professor of Organic Chemistry, Unisersity of Michigan, May, 1925.
C. A. Kraus, Professor of Organic Chemistry, Brown University, Providence, R. I., 1926.
John J. Abel, Professor of Pharmacology, Johns Hopkins University, May, 1927.
W. D. Harkins, Professor of Chemistry, University of Chicago, 1928.

As a result of this award we believe the Chicago Section has done more to call attention to Willard Gibbs and his work, than has any other organization.

We should be very happy to have you make mention of this in your journal as we out here agree with you that Willard Gibbs is entitled to the respect of every American chemist and no opportunity should be lost to bestow this credit publicly.

S. L. REDMAN.
Chairman,
Chicago Section,
American Chemical Society.

EDITOR'S NOTE. The Chicago Section's very commendable recognition of Willard Gibbs was not referred to in our editorial—not because we were unaware of the Willard Gibbs medal—but rather because our comment was largely confined to Dr. John Johnston's plea for the establishment of a Gibbs professorship at Yale University.

Questions Cost of Synthetic Ammonia

To the Editor of Chem. & Met.:

Sir—I have read with a great deal of interest the articles by Prof. R. S. Tour in the February and March issues relating to Synthetic Ammonia Costs in America.

Professor Tour's data relating to plant costs and his method of loading the charges upon the final product are so at variance with my conception of ammonia costs at Muscle Shoals that I am compelled to take issue with him relative to the production cost of $126 per ton for water gas ammonia and $135 per ton for electrolytic ammonia. It is possible that the full text of the paper presented at the American Institute of Chemical Engineers, which I have not seen, would satisfy me that many of my existing objections are untenable, for which reason I will now object to but one of the principal items of the presentations.

In Table II, Plant Cost Summaries, the electrolytic hydrogen ammonia gas manufacturing plant is set out as $7,345,000. This includes electrical converting equipment, electrolytic plant and liquid air nitrogen plant complete ready for use.

I shall assume, for want of evidence to the contrary, that the liquid air nitrogen carrying its proper proportion of charges will cost twenty cents per M. cu.ft.

I can substantiate that nitrogen freed from air by electrolytic hydrogen in the production of a nitrogen-hydrogen gas mixture will cost less than twenty cents per thousand cu.ft. when energy costs three mills per kw.-hr. There is no need, therefore, of loading the electrolytic ammonia plant with a liquid air nitrogen plant.

Using approximately the same per cent utilization of gas as Professor Tour I have a requirement for 90,000 cu.ft. of hydrogen per ton of ammonia gas mixture, or 500,000 cu.ft. per hr. for a six-ton per hr. ammonia plant having an output of 5.55 tons per hr. For this we need 2,667 cells at 12,000 amperes and 1.9 volts with energy at three mills per kw.-hr., or 2.0 volts when energy is two mills per kw.-hr. Energy is more likely to be subsidized to two mills than three mills for the actual cost is more nearly four mills per kw.-hr. I will use the three-mill rate but will draw attention to the fact that the electrolytic and conversion plant for the two-mill rate will be about $550,000 less expensive.

The plant for gas manufacture, complete and ready to receive a.c. energy at three mills per kw.-hr., treated water at 25c. per 1,000 gal., exhaust steam at 20c. per 1,000 lb. and delivering oxygen and hydrogen gases of high purity, will cost $4,500,000. This makes the

Capital cost per annual ton N_2	$112.50
Labor cost for gas plant complete, operation and maintenance	120,000
Materials cost, including water and exhaust steam for operation and maintenance	130,000

The production of 500,000 cu.ft. of hydrogen per hr.

is accompanied by 10.9 tons of oxygen as a by-product. This amounts to 2,190,000,000 cu.ft. per year and at least one-half of it can be used in the conversion of NH_3 to fertilizer or other saleable products. The remainder can be liquefied and transported profitably to markets available for the absorption of over 2,000,000,000 cu.ft. annually at a profit when the cell cost of the oxygen is taken as 25c. per 1,000 cubic feet or $6 per ton. This credit clearly belongs to the electrolytic process and will be taken.

There is no market, nor is there likely to be a market at Muscle Shoals for 48,570 tons per year of anhydrous ammonia. The ammonia, however, can be used in the production of other end products and probably can be disposed of in no other way. All expense, therefore, which relates to minimum and seasonal stock is chargeable to the end products and not to the ammonia process.

Professor Tour has arranged to pay interest on everything a banker could hope to cover but it is on more than a banker would expect to have included if the economics of cost and market are right. A part of this investment is speculative and participates only in the surplus earnings. For depreciation Professor Tour takes a rate which, at compound interest, will return the capital in less than fifteen years. He charges annually in the operating and maintenance of plant for the upkeep of the apparatus, which in part duplicates the depreciation, and then charges for something he calls obsolescence at a rate which reproduces the capital in less than eighteen years. As the life of the plant is taken at 20.7 years these conclusions have the appearance of having been prepared for those who like "to eat their cake and still have it."

Substituting in Table VIII for the above stated costs we have:

Table VIII, Ammonia Production Costs

48,570 tons NH_3 per year. Cost per ton NH_3 produced:

Process Operation	Electrolytic Ammonia	
Labor	$4.60	
Materials	2.00	
Supplies	1.26	
Power	37.90	
		$45.76
General Plant Expense		10.03
Current Maintenance		
Labor	1.00	
Supplies	6.50	
		7.50
Miscellaneous		7.69
		$70.98
Brought Forward		70.98
Fixed Charges		
Depreciation	$10.15	
Obsolescence	8.15	
Interest	16.20	
Taxes and insurance	5.38	
		39.88
Gross Cost per Ton, NH_3		$110.86
Credit for 95,000 tons O_2		11.80
Net Cost per Ton, NH_3		$99.06

If accepted as a rational exposition of the costs of fertilizer based on synthetic ammonia it will react very nicely as a deterrent. If, on the other hand, profits are put where they belong, in the surplus, and the expense of carrying stock is omitted from this branch of manufacture where it does not belong we will find that synthetic ammonia for fertilizer manufacture can be had at Muscle Shoals for about $70 per ton with power at $20 per hp.-yr. and at $50 per ton when power is $12.

Consulting Engineer
Toronto, Ontario. FARLEY G. CLARK.

Professor Tour Answers Criticism

To the Editor of Chem. & Met.

Sir—I take pleasure in replying to Farley G. Clark's letter in which he takes exception to certain figures developed in my articles on "Synthetic Ammonia Costs in America." I shall take up his points in the order in which he presents them.

The gas manufacturing plant cost for electrolytic hydrogen ammonia covers more than the direct current substation and the electrolytic cell house, viz.,

Direct current substation	$1,430,000
Electrolytic cell house	3,710,000
Steam plant and stills	125,000
Liquid air nitrogen plant	530,000
Mixing and deoxidation	235,000
Gas and ammonia holders	555,000
Miscellaneous and contingencies	660,000
Total	$7,345,000

The use of Clark cells might call for a somewhat lower investment than that allowed for cells in my article, but engineers often differ on the choice of equipment.

Twenty cents per M cu.ft. for liquid air nitrogen is far too high a figure to be assumed for a large installation. Even this figure requires that hydrogen be available at 37½c. per M cu.ft. if the hydrogen combustion process of producing nitrogen is to compete. Only under special circumstances or in small plants can nitrogen be obtained more cheaply by burning hydrogen in air than by air liquefaction.

For "loading the electrolytic ammonia plant with a liquid air nitrogen plant," I can but offer the same excuse as one must for a "loading" with additional hydrogen cells for the combustion process of producing nitrogen. I am certain the former "loading" is the lesser in the general case.

As pointed out in my complete paper, the electrolytic cell investment could be reduced if cheaper power were available. This agrees with Mr. Clark's contention. A 3-mill power cost was chosen as representative of very cheap power. A "subsidized power" supply can not be considered for general cost estimates until such a supply is available.

Production costs may be figured on a unit basis as Mr. Clark has done in allowing "water at 25c. per M gallons, exhaust steam at 20c. per M pounds," etc. Of course, one must make certain there is exhaust steam where power is available at 3 mills. Or costs may be figured by totals as I have done. Either method must lead to similar results if the assumptions made in each case are the same. Mr. Clark and I will differ somewhat here since our respective points of view are from different angles. This will also apply to labor and materials costs for operating Clark cells and related equipment.

The oxygen available as a byproduct from electrolytic cells if sold profitably may be rightfully credited against the cost of the product ammonia. My paper presumed to develop only gross overall costs. It will be noted that I assumed no credit for the carbon dioxide of the water gas process. However, I must take exception to a credit of 25c. per M cu.ft. for all the oxygen produced in this size plant located where power is available at 3 mills. In the general case, I fear that compression, cylinder, handling, transportation, and accounting costs, together with a variable demand would leave but little credit available from the oxygen.

In Mr. Clark's tabulation of costs offered in substitution for my Table VIII, I note decided reductions in process labor cost, and in maintenance labor cost. Have these costs perhaps been limited to the gas production in which Mr. Clark is particularly interested? My Table III indicates a labor cost of $4.73 for the ammonia synthesis alone as distinct from gas manufacture, while Mr. Clark allows but $4.60 for a total labor cost. A maintenance labor charge on the compressors, converters, liquefiers, etc., of the high pressure end of the process is never quoted as $1 per ton NH_3 by the most optimistic. Maintenance labor at $1 per ton totals but 1/3 of 1% on the plant cost. Mr. Clark's other items as listed seem of the proper order of magnitude although they vary from mine in one direction always; again probably due to a difference in points of view.

My article was not concerned with Muscle Shoals. My paper referred to a general case selected for general application. Nor was any special market for anhydrous ammonia considered. The market assumed for the large output of the plant was the fertilizer industry to which market every large scale ammonia plant must turn. The fertilizer market is admittedly a seasonal one and the carrying charges for the ammonia between seasonal peaks must therefore be borne by the product being carried. After all, this is a matter of bookkeeping and can be made to appear somewhat as desired, excepting that final total costs must be borne by the consumer of the ammonia.

As Mr. Clark so clearly states, I have allowed interest payments on everything that involves capital investment; I doubt whether money can be obtained otherwise. I can not agree that part of the investment is speculative while allowing but a 6 per cent return: either 6 per cent on total investment must be forthcoming or a greater return must be hoped for to cover the speculative risk. Speculative or surplus earnings generally go to "common" stock representing little or no capital investment. In discussing the banking, attention is called to the fact that no charge has been made for financing (brokers' fees) or promoting.

I believe that but few will question an allowed life of 20.7 years for a synthetic ammonia plant, since this approximates the accepted values for the life of standard plants, i.e., power plants, substations, gas plants, etc. As to whether the depreciation during this useful life should be calculated as a sinking fund (compound interest) or as straight line depreciation or by composite methods is a point open to discussion, but such discussion is not within the scope of my paper nor this letter. To indicate that at compound interest the depreciation rate "will return the capital in less than 15 years" or that the obsolescence rate "reproduces the capital in less than 18 years" is misleading, as would be the perfectly true statement that an interest return of 6 per cent compounded replaces the capital in 12 years. The latter fact in no way modifies the necessity of paying 6 per cent continuously for the use of capital. Such analyses all smack of "eating cake and having it" as Mr. Clark puts it.

I must take exception to the statement that my maintenance charges in part duplicate depreciation. The distinction between these two is generally hazy to the laymen in cost accounting and I therefore went to great lengths in my paper to distinguish between the two (see p. 162 of March, 1928, *Chem. & Met.*).

Bookkeeping may allow an interchange of costs under the two heads of maintenance and of depreciation, but this possible interchange must not be construed as duplication. Such juggling may yield low apparent maintenance costs with high depreciation charges or the converse, but bookkeeping can not bring about low charges for both. We cannot make the statement that *with proper care* the life of a compressor is 50 years, after having stated that the maintenance charges on a compressor are low because some existing plants have found them so during 5 or 10 years' operation. Such fallacies are common.

As mentioned before, my paper had no particular reference to Muscle Shoals, but I happen to be quite well acquainted with the situation there. I fail to see how bookkeeping methods arranged to charge certain costs to fertilizer manufacture rather than to the nitrogen can reduce the cost of the finished fertilizer even though these methods may yield an apparently attractive cost for the ammonia. Such "attractive costs" must decrease the sale price of ammonia to the fertilizer manufacturer if he is to be loaded with the burdensome charges and still market the product to the ultimate consumer. Thus the burden reacts as a decreased return to the ammonia manufacturer and constitutes a true cost if the sales price to the ultimate consumer is used as a criterion of profit. Bookkeeping can not make money, whatever its apparent results.

In closing, may I quote from my complete paper, "Should the costs developed in this paper be compared with other cost figures on the synthesis of ammonia—the very natural tendency of most engineers toward underestimating must always be kept in mind. Perhaps the basis for the phenomenon of underestimating is the psychological fact that most men are optimists. The hope that work can be done cheaply is father to the too low estimate." R. S. Tour.

Professor of Chemical Engineering,
University of Cincinnati,
Cincinnati, Ohio.

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Opportunity for a Pulp and Paper Industry

To the Editor of Chem. & Met.:

Sir—I am writing to call your attention to the hardwood timber resources of this section and its advantages for a paper and pulp mill, if the semi-chemical process of the U. S. Forest Products Laboratory is a success. This parish has an area of 360,000 acres, 22 per cent of which is in cultivation with the balance in hardwood cut-over lands which will average over 2,000 ft. of small timber per acre. Nearly all of this would be available if a market were established.

Rayville, the parish site, is located at the crossing of the Illinois Central and Missouri Pacific Railways, the former traversing the parish from east to west and the latter from north to south.

For fuel, a gas field has been developed, and since its discovery, November 1, 1926, 32 wells, with a daily open flow capacity of over one billion feet, have been opened.

Abundant water is obtained at a depth of 40 ft. and an artesian flow at about 500 ft.; also Boeuf River, an ever-flowing stream, traverses the entire length of the parish.

With this combination, raw material, cheap fuel, excellent transportation facilities and an abundant water supply, it appears to me an ideal location for a pulp and paper mill or other chemical industry. W. H. Burris.

Rayville, La.

CHEMICAL ENGINEER'S BOOKSHELF

Annual Survey of Chemistry

ANNUAL SURVEY OF AMERICAN CHEMISTRY. Vol. II. Edited by *Clarence J. West* under the auspices of the Division of Chemistry and Chemical Technology of the National Research Council. The Chemical Catalog Company, Inc., New York. 1927. 415 pp. Price, $3.

Reviewed by D. B. KEYES

INDUSTRIAL chemical research organizations should appreciate the publication of this Annual Survey of American Chemistry. They should also be grateful to Dr. Wm. J. Hale who initiated this survey, and to Dr. Clarence J. West who has so ably edited the two volumes that have appeared thus far.

Many of the great industrial developments have been started by a research worker who has noticed in some brief abstract an idea that would be applicable to his own industry. It has long been conceded that the Abstracts of the American Chemical Society are the most valuable of the Society's publications to the man in the industry. It is therefore conceivable that this Survey will prove the most valuable publication of the National Research Council from the standpoint of industrial chemistry.

The second edition is much larger than the first. More subjects are treated and more contributors have given their services. It should be noted that the Survey is not confined to work by Americans and every means is taken to give a well balanced picture of any particular type of work regardless of where that work was done. The survey is, of course, not complete, but no glaring omissions are evident, which is all that can be expected. The subjects covered are varied and seem to have been selected to fit the contributors. This does not follow the custom of previous reviews. This is unique and much could be said for the plan.

This Survey is bound to stimulate thought and action in our industrial research laboratories, and its success is already assured.

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Leather Chemistry

THE CHEMISTRY OF LEATHER MANUFACTURE. Second Edition, Vol. I. By *John Arthur Wilson.* The Chemical Catalog Company, Inc., New York. 1928. 495 pages. Price, $10.

THOSE familiar with the first edition of this monograph will find that it has had a considerable growth in its present new appearance. Not only have two volumes become necessary in this edition, but, in addition, the first volume alone is now larger than the original work. This expansion, the author states, has been due to the many new suggestions and criticisms offered in the interval since 1923 both here and in Europe, where three translations of the work have appeared.

The new first volume treats in detail the general properties of skins and their constituents, the nature of influential micro-organisms, and the individual processes of preservation, unhairing, scudding, bating, pickling, and tanning,—always with a searching emphasis on the chemical and physical actions involved. The growing comprehension of leather manufacture as a science, rather than as a craft, is thus again brought up to date in a clear satisfying manner. The text is supplemented by numerous graphs and illustrations, the photomicrographs being particularly excellent.

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Scientific Dairying

FUNDAMENTALS OF DAIRY SCIENCE. American Chemical Society Monograph No. 41. By Associates of *Lore A. Rogers.* The Chemical Catalog Company, Inc., New York. 543 pages. Price, $5.50.

Reviewed by F. L. SEYMOUR-JONES

The published facts of dairy science are so scattered in the literature that every dairy research chemist has longed for a book like this. It is a well documented collection, and critical discussion of the basic facts of the chemistry, bacteriology and nutritional value of milk and milk products. To the chemical engineer it offers many valuable data. He will find no enlightenment, for instance, on the action of milk on materials of construction, but he will find much fundamental information which he should be able to apply profitably. It is full of leads which are conducive to useful research.

The present and former colleagues of L. A. Rogers deserve congratulation for the excellence of this well-merited tribute to a pioneer of dairy science.

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THERMIONIC PHENOMENA. By *Eugene Bloch;* translated by *G. R. Clark.* E. P. Dutton & Co., New York. 145 pages. Price, $2.50.

Reviewed by B. E. SHACKELFORD

THIS volume is mainly an abstract of Richardson's "The Emission of Electricity from Hot Bodies," and of various publications of Langmuir's. No date of publication or copyright is given, perhaps because the book contains few references to work carried out in the last ten years. Aside from a number of inaccuracies in facts and wording, it should be noted that there is very little discussion of experimental methods, and very little of importance relative to recent progress in the field of applications of thermionic phenomena. About one-fourth of the reading matter is given over to emission of positive ions from metals and emission of ions by salts.

The volume is too inclusive for the non-technical reader and of little, if any, value to one familiar with the subject.

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DESTILLIEREN UND REKTIFIZIEREN. By *Dr. Kurt Thormann.* Otto Spamer, Leipzig, Germany. 1928. 114 pages. Price, 12 M.

As a monograph dealing with fractionation, this book endeavors to present succinctly the true processes taking place in the distillation of various mixtures. Introduced by a short discussion of the phase rule and the properties of mixtures, it goes on to illustrate their application to the fractionating apparatus of modern practice. Because of its especial importance today alcohol distillation has an additional separate treatment. The book is equipped with 65 illustrations and 4 convenient tables.

Selections from Recent Literature

COLLOID MILLS. Franz Meyer. Chemische Fabrik, Jan. 18, pp. 31-2. Brief illustrated description of the construction and mode of operation of the Premier mill. It is especially useful in making emulsions of tar, waxes, bitumens, resins, soaps, fats, oils and the like for all manner of commercial products.

AZOIC COLORS. E. J. Rath. Journal of the Society of Dyers and Colourists, Jan., pp. 10-3; discussion, p. 14. Substantivity, a vital factor in successful application of Naphthol AS dyes (particularly in continuous dyeing), is governed by 5 factors, all subject to control in the dye bath. They are: colloidal state, temperature, time, concentration, and proportion of cotton to liquor. Optimum conditions are discussed.

DRY CLEANING MACHINERY. E. A. Alliott and A. E. Hatfield. Chemistry and Industry, Feb. 10, pp. 139-52. Illustrated description of open, enclosed and vacuum washers; solvent recovery plant; stills; equipment for continuous system cleaning; filters and filter presses. The new continuous system which is described can also be adapted to laundry washing. Diagrams and photographs are shown.

SPINNING RAYON. Johann Eggert. Chemiker-Zeitung, Feb. 15, pp. 129-30. Advantages and disadvantages of the centrifugal spinning machine are compared with the older method of spool spinning. The centrifugal machine is so complicated and expensive that ample capital and facilities for maintaining a stock of spare parts and the necessary force of skilled labor must be available if the centrifugal system is to be adopted.

REACTION VESSEL. Ernst Hochberger. Chemiker-Zeitung, Feb. 15, pp. 130-1. All the disadvantages of the reaction vessel equipped with stirrer or internal mixer for processing solid-liquid mixtures are eliminated by use of a rotary reactor which has no internal moving parts. It carries a bent pipe which is turned up during use to permit escape or collection of air or gases and is turned down after use to permit discharge of the contents by blowing. Illustrated.

LEAD WARE. Brenthel. Chemiker-Zeitung, Feb. 29, pp. 169-70; March 7, pp. 190-2; March 14, p. 213. Sheet lead, with its advantages of easy application and repair, its adaptability and ease of recovery as scrap lead, is one of the most useful acid-proofing materials. Descriptions and photographs are given of lead lined pipes, tanks, evaporators, autoclaves and gas apparatus, and of sheet lead electrodes, kettles and the like.

CORROSION. U. R. Evans, Journal of the Society of Chemical Industry, March 23, pp. 73-7T. In a study of the protection of steel by other metals it was observed that Cu and Ni are usually cathodic towards steel; Zn and Cd are usually anodic; Sn, Pb and (under some conditions) Al are variable. Corrosion of half immersed samples was measured (by loss in weight, in salt water and other water solutions. Cu accelerated corrosion; Ni had less effect, and Pb still less. Zn protected the steel in most liquids, but in some cases with serious loss of Zn.

PRODUCTS OF COKING. Harold H. Thomas. Journal of the Society of Chemical Industry, March 23, pp. 77-83T. Temperature, size of coal, addition of coke and of inert material and addition of non-coking coal were studied as factors in rate of carbonization and nature of the coking products. Curves are included to show rate of gas yield as a function of some of these factors. Considerable improvement in reactivity of the coke was effected by suitable selection of coals and proportions for blending the charge.

CHEMICAL PLANT STANDARDIZATION. G. Baganz. Chemische Fabrik, March 14, pp. 131-3. Unit operations, common to chemical factories, are divided into nine classes, all of which come under one of five general heads: (1) measuring materials (at rest or in motion); (2) control of proportions of materials; (3) operation and maintenance of tools and machinery; (4) measurement, control and adjustment of physical properties or states; and (5) operating studies. Some suggestions are offered for reducing these operations to systematic control, which may be centralized.

USES OF MOTOR TRUCKS. L. Betz. Chemische Fabrik, March 14, pp. 133-4. A short discussion of uses of motor trucks in chemical plants, e.g., as a source of emergency power, handling and transport of heavy materials, and the like. Much greater use than at present could be made of portable cranes mounted on trucks. Illustrated.

CATALYTIC GAS REACTIONS. L. Duparc, P. Wenger and C. Urfer. Helvetice Chimica Acta, March, pp. 337-48. Experiments were made in catalytic oxidation of NH_3 and in catalytic reduction of oxides of N to NH_3, using prepared catalysts of the Pt group. Results indicate that gas reaction catalysis by these metals is chemical in nature rather than physical. In using these catalysts in gas reactions, therefore, conditions should be adjusted accordingly. For instance, one of the limitations is that free nitrogen must be in the atomic state to be hydrogenated.

ELECTROCHEMICAL REACTIONS. Hans Erlenmeyer. Helvetica Chimica Acta, March, pp. 348-54. The slowing down of electrolytic processes under pressure, sometimes observed, may be due to indirect causes, e.g., insufficient stirring, rather than to the pressure itself. Experiments on such processes as passivation of Ni. electrodes and anodic solution of Cu indicate that pressure as such does not influence the rate.

MAKING GAS. Kausch. Wasser und Gas, Feb. 15, pp. 497-505. A review of recent advances in the chemistry and tehnology of manufature of produer gas, water gas and mixed gas fuels. Particular attention is given to the patent literature.

ACTIVATED SLUDGE. Pritzkow and Jordan. Wasser und Gas, March 1, pp. 556-7. Under necessity of disposing of a strongly colored sewage, a trial was made with the activated sludge process. The result was quite sratisfactory as to chemical composition and stability but there was not much decolorizing effect. Other means were necessary to remove the color, which came from several dyeing establishments discharging into the sewage. An attempt is being made to modify the activated sludge process to include decolorization in one operation.

GLASS TANKS. E. F. Carty. Glass, Feb., pp. 54-6. In view of the advantages to be gained, water cooling of glass tanks and furnaces should be even more generally practiced than it is at present. Equipment for water cooling is described and illustrated with diagrams. With soft water the effluent temperature may be 170 to 180° C.; with scale-forming water the temperature should be at least 10° C. below the precipitating point, even though more water is then required.

ROSIN IN PAPER. Pierre Delcroix. Le Papier, Jan., pp. 69-74. A new method of dispersing rosin prior to its incorporation in paper pulp has been developed. The advantages are fine dispersion, saving in labor and steam, quality of product and simplicity of process. The method is based on a cold treatment of lump rosin with moderately concentrated NaOH solutions. It is applicable in other industries than paper, and so deserves general attention.

WOOD IMPREGNATION. A. Bresser. Kunststoffe, March, pp. 55-8. The new American method of impregnating wood with molten S is useful not only for its preservative effect but also for the induration which improves the mechanical properties of the wood. Most woods (except oak) have about the same absorption capacity for S. In the use of paraffin, temperature control of the paraffin bath is essential but otherwise the process is quite simple. The newest advance in wood preservation is the use of beechwood tar, which has excellent fungicidal properties.

STEAM ACCUMULATORS. Julius Oelschläger. Chemische Fabrik, March 7, pp. 115-7. A description of the Ruths accumulator and of the equal pressure type, and their uses in storing excess power for use at times of peak load. A modified construction can even be used to store excess electrical energy. Illustrated with curves, diagrams and photographs.

LARGE CENTRIFUGES. Gustav Venske. Chemische Fabrik, March 7, pp. 118-9. Illustrated description of the Haubold semi-automatic centrifuge with 1,500 mm. (60 inch) basket, which may be made of steel, copper, bronze, etc., and may be tinned, galvanized or lined with lead or rubber according to the intended use. The machine is used for dewatering or separating any crystalline or short fiber material.

PAINT MATERIALS. Johannes Scheiber. Farbe und Lack, Feb. 15, pp. 68-9; Feb. 22, pp. 80-1; Feb. 29, pp. 93-4; March 7, p. 106. A discussion of the principles involved in proper combination of pigments and like materials with film forming (binding) agents in reversible and irreversible aqueous systems (tempers, glue and casein paints, etc.), and in reversible and irreversible non-aqueous media (paints, varnishes and lacquers), to produce durable protective and ornamental coatings.

LUBRICATING OILS. Arthur R. Taylor. Chemistry and Industry, Jan. 6, 1928, pp. 2-7. General description of the nature and applications of lubricating oils. The animal and vegetable oils are included. The standard tests are indicated and various fields of service of oils in machinery are defined.

ULTRA VIOLET RADIATION IN INDUSTRY. Alfred S. King. Chemistry and Industry, March 23, 1928, pp. 301-305. Research work on this type of energy must be left to the chemist and physicist; meanwhile the chemical engineer has it at his command as a useful tool. Its action is similar to that of sunlight: it may thus be applied for bleaching action, for catalysis and for analysis. A related use in industry is the combating of various diseases among the workers.

RUBBER COMPOUNDING. Webster Norris. India Rubber World, April 1, 1928, pp. 59-61. Various types of pigments are compounded with rubber for purposes of coloration and reinforcement. They are here discussed in regard to their hiding power and discoloration upon treating. The methods employed for testing their tinting power are described.

PAINTING SERVICE PIPE. Gas-Age Record. March 31, 1928, p. 432. A painting machine has been devised to give protective coating to pipe lines, replacing the less economical and satisfactory painting by hand. The paint consumption is higher, but this factor is more than compensated for.

FUNCTIONS OF THE CHEMICAL ENGINEER. Brig.-Gen. Sir William Alexander, The Chemical Age, March 17, 1928, p. 240. In the past the chemist has provided the *bread* of business and the engineer the *butter*. The chemical engineer, in tending to combine the service of both, is not a strictly definable entity: he must pursue a general profession in a particular atmosphere. The field of organic solvents and of waste-elimination the writer finds to be two fertile fields for cultivation by the chemical engineer.

Government Publications

Prices indicated are charged by the Superintendent of Documents, Washington, D. C., for pamphlets. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from Bureau responsible for issue.

Mineral Resources of the United States in 1926. Rare Metals by Frank L. Hess; Secondary Metals by J. P. Dunlop; Gold, Silver, Copper, Lead and Zinc in Oregon and California by James M. Hill; Sand and Gravel by Estelle R. Phillips. Bureau of Mines, Nos. I:15-I:17, II:25. 5 cents each.

U. S. Government Master Specifications for Cells and Batteries, Dry. No. 139.

Record Book of Business Statistics, a supplement to the Bureau of the Census Survey of Current Business. Data are summarized for production, imports, exports, consumption, etc., for various products over a period of years. These data will ultimately take the form of a bound volume, but each chapter is being issued in separate pamphlet form. Two chapters are now available, as follows: I—Textile Section, II—Metals and Machinery. 10 cents each.

Formulae for Completely and Specially Denatured Alcohol. Bureau of Prohibition, Appendix to Regulations No. 3 (formerly 61), revised February, 1928. 5 cents.

Methods of Extracting Volatile Oils From Plant Material and the Production of Such Oils in the United States, by Arthur F. Sievers. Bureau of Animal Industry Technical Bulletin 16. 10 cents.

Chemical Character of Waters of Florida, by W. D. Collins and C. S. Howard. U. S. Geological Survey Water-Supply Paper 596-G. 10 cents.

Notes on Practical Water Analysis, by W. D. Collins. U. S. Geological Survey Water-Supply Paper 596-H. 10 cents.

Phosphate Rock in the Three Forks-Yellowstone Park Region, Montana, by D. D. Condit, E. H. Finch, and J. T. Pardee. U. S. Geological Survey Bulletin 795-G. Edition exhausted, available only by consultation in libraries maintaining such document files.

Some Principles Governing the Choice and Utilization of Permanent-Magnet Steels, by R. L. Sanford. Bureau of Standards Scientific Paper 567. 5 cents.

Deterioration of Steels in the Synthesis of Ammonia, by J. S. Vanick, W. W. DeSveshnikoff, and J. G. Thompson. Bureau of Standards Technologic Paper 361. 15 cents.

Thermal Expansion of Alloys of the "Stainless Iron" Type, by Peter Hidnert and W. T. Sweeney. Bureau of Standards Scientific Paper 570. 10 cents.

Light Metals and Alloys—Aluminum, Magnesium. Bureau of Standards Circular 346. $1.10.

Directory of Commercial Testing and College Research Laboratories. Bureau of Standards Miscellaneous Publication 90, 2nd edition. 15 cents.

Thermal Insulation. Bureau of Standards Letter Circular 227, dated April 19, 1927.

United States Government Master Specification for Dry Cells and Batteries, Bureau of Standards Circular 139, 2nd edition. 5 cents.

United States Government Master Specification for Lithopone Paint. Bureau of Standards Circular 111, 3d edition. 5 cents.

Analyses of Oklahoma Coals. Bureau of Mines Technical Paper 411. 10 cents.

Limits of Inflammability of Gases and Vapors, by H. F. Coward and G. W. Jones. Bureau of Mines Bulletin 279. 20 cents.

Use of the Miners' Self-Rescuer, by S. H. Katz and J. J. Forbes. Bureau of Mines Miners' Circular 30. 10 cents.

Methods of Dealing with Paraffin Troubles Encountered in Producing Crude Oil, by C. E. Reistle, Jr. Bureau of Mines Technical Paper 414. 15 cents.

Electric-Furnace Cast Iron, by C. E. Williams and C. E. Sims. Bureau of Mines Technical Paper 418. 10 cents.

Work of the Experiment Stations of the Bureau of Mines, by A. C. Fieldner and Alden H. Emery. Bureau of Mines Information Circular 6060.

Mineral production statistics for 1926 —separate pamphlets from Bureau of Mines on: Barite and Barium Products, by R. M. Santmyers and A. Stoll, 5 cents; Gold, Silver, Copper, Lead, and Zinc in California and Oregon, by James M. Hill, 10 cents; Secondary Metals, by J. P. Dunlop, 5 cents; Lead, by Amy Stoll, 5 cents; Sand and Gravel, by Estelle R. Phillips, 5 cents.

Mineral production statistics for 1927 —preliminary mimeographed statements from Bureau of Mines on: Magnesite, Sulphur and Pyrites, Molybdenum, Phosphate Rock, and Fuel Briquets.

THE PLANT NOTEBOOK
an exchange for OPERATING MEN

Design of Heating Elements for Electric Furnaces

By G. I. Le Baron
Pittsburgh, Pa.

Occasion frequently arises in the laboratory or plant when it is necessary to replace a burned-out heating element in an electric furnace or possibly to design a furnace for experimental or even for actual industrial use. Rectangular ribbon resistance units form a convenient type of element, while the calculation of the most economical dimensions is found to be comparatively simple when a mathematical analysis of the subject has been made. The most economical unit will be one which combines minimum length of wire with minimum cross-sectional area and still fulfills the stated load requirements.

If the problem dealt with round rather than with rectangular sections, the relation between the surface area and the cross-sectional area would be constant for various wire sizes. Surface area is an essential factor in determining the thermal loading in watts per square inch of resistor and is thus of great importance in the design of a furnace. In the case of rectangular wires, the surface area may vary widely for the same cross-sectional area dependent upon the width of the ribbon in proportion to its thickness. For example, a bar of cross section $\frac{1}{4} \times \frac{1}{4}$ in. will have the same cross sectional area as a ribbon $\frac{1}{16} \times 1$ in. However, the surface area per inch of length in the first case is 1 sq.in., and in the second case is $2\frac{1}{8}$ sq.in.

The allowable thermal loading is directly dependent upon the type of service for which the furnace is to be used. For a completely muffled resistor unit, a thermal loading of only 3 or 4 watts per sq.in. is permissible, while in a unit very frequently exposed to the air a density of 10 to 12 watts per sq.in. may be used safely.

The problem resolves itself into a consideration of several factors. With the kilowatt load per phase and the voltage per phase known, and a safe thermal loading assumed, then the problem becomes one of determining the lowest cost unit from the standpoint of length and cross-sectional dimensions which will completely fulfill the stated requirements. It is not at all difficult to determine the length and cross-section of ribbon to produce a given power output when the thermal loading is not taken into consideration. However, though the dimensions may be so chosen that the thermal loading is safe, the designer ordinarily has no assurance that his solution has been the most economical one obtainable. The following discussion presents a system for insuring this desirable result.

Obviously, the watt output of a unit of definite length and impressed voltage varies directly with the cross-sectional area of the ribbon. The thermal loading, however, varies directly with the power output and inversely as the surface area. Since both the conditions of power output and thermal loading must be satisfied it is apparent that some form of simultaneous equations must be solved. These equations may be derived by the method described below.

Let R_p equal the resistance per phase, E_p equal the voltage per phase, and W_p equal the power in watts per phase. Then if we take rh for the hot resistance of the wire in ohms per foot and L as the number of feet required,

$$R_p = \frac{(E_p)^2}{W_p}$$

and

$$L = \frac{R_p}{rh} \text{ ft.} \qquad (1)$$

This equation provides for a sufficient length of wire to give the requisite power output. In order to take care of the thermal loading we may set down the equation

$$d = \frac{W_p}{12 \times 2\,(w+t)L} \text{ watts per sq. in.}$$

where d is equal to the thermal loading, w is equal to width and t to thickness of the ribbon. Solving this equation for L we have

$$L = \frac{W_p}{24d\,(w+t)}$$

and placing $\frac{W_p}{24d}$ equal to B and $(w+t)$, the semi-perimeter, equal to s,

$$L = \frac{B}{s} \text{ ft.} \qquad (2)$$

While the simultaneous solution of equations (1) and (2) may at first glance seem to be fairly easy, on closer examination it is apparent that there is no simple relation between rh and s. An easy solution to the problem is provided by a table which is made up on the basis of specifications for a standard make of resistance ribbon. While this table is based upon 80-20 nickel-chromium rectangular ribbon, there is no reason why a similar table cannot be calculated for any other resistance material. The table shows that rh increases continuously as the size of the ribbon decreases, while $(w+t)$ oscillates but gradually decreases. Since these two functions are moving in opposite directions, it is evident that they have one or more points of crossing. However, it is also clear that of the various sizes of wire which will fulfill equation (1) and of the various sizes which will likewise fulfill equation (2) there is just one size which will give a minimum length of wire for both equations. This marks the desired economical size for the problem in question.

A specific example will serve in making the use of the table and equations clear. Let us assume a furnace for the following rating and determine the most economical ribbon specifications.

Power: 120 kw. $= W$
Voltage: 220 $= E$
Phase: 3-phase, Y-connection $= p$

Constants for 80-20 Nickel-Chromium Rectangular Ribbon

Ribbon Number	Ribbon Size, Inches*	Hot Resistance, Ohms per Ft. rh	Semi-Perimeter s	Surface Area, per Ft. $24s$	Cross Sectional Area wt
1	$1\frac{1}{2} \times \frac{1}{4}$	0.002464	1.875	45.00	0.219
2	$1\frac{1}{2} \times 0.10$	0.003080	1.850	44.40	0.175
3	$1\frac{1}{2} \times 0.10$	0.003597	1.600	38.40	0.150
4	$1\frac{1}{2} \times 0.08$	0.003850	1.830	43.92	0.140
5	$1\frac{1}{2} \times 0.07$	0.004400	1.820	43.70	0.123
6	$1\frac{1}{2} \times 0.08$	0.004499	1.580	37.92	0.120
7	$1\frac{1}{2} \times 0.06$	0.005137	1.810	43.45	0.105
8	$1\frac{1}{2} \times 0.07$	0.005137	1.570	37.68	0.105
9	1×0.10	0.005401	1.100	26.40	0.100
10	$1\frac{1}{2} \times 0.06$	0.005995	1.560	37.45	0.090
11	$1\frac{1}{2} \times 0.05$	0.006171	1.800	43.20	0.088
12	1×0.08	0.006743	1.080	25.90	0.080
13	$1\frac{1}{2} \times 0.05$	0.007194	1.550	37.20	0.075
14	$1\frac{1}{2} \times 0.04$	0.007711	1.790	42.95	0.070
15	1×0.07	0.007711	1.070	25.68	0.070
16	1×0.06	0.008998	1.060	25.42	0.060
17	$1\frac{1}{2} \times 0.04$	0.009020	1.540	37.00	0.060
18	$1\frac{1}{2} \times 0.03$	0.010285	1.780	42.70	0.053
19	1×0.05	0.010802	1.050	25.20	0.050
20	$1\frac{1}{2} \times 0.03$	0.11990	1.530	36.75	0.045
21	1×0.04	0.013530	1.040	24.98	0.040
22	$1\frac{1}{2} \times 0.02$	0.015400	1.770	42.50	0.035
23	$1\frac{1}{2} \times 0.02$	0.018040	1.520	36.50	0.030
24	1×0.03	0.018040	1.030	24.72	0.030
25	1×0.02	0.026950	1.020	24.48	0.020

*By courtesy of the Hoskins Mfg. Co., Detroit, Mich.

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Thermal loading:
10 watts per sq.in. $= d$

Then $W_p = \frac{120}{3} \times 1{,}000 = 40{,}000$ watts per phase

$$B = \frac{W_p}{24d} = \frac{40{,}000}{24 \times 10} = 166.6$$

$$E_p = \frac{220}{\sqrt{3}} = 127 \text{ volts per phase}$$

$$R_p = \frac{(E_p)^2}{W_p} = \frac{16{,}133}{40{,}000}$$

$= 0.4033$ ohms per phase

From equation (1)

$$L = \frac{0.4033}{rh} \text{ ft.}$$

From equation (2)

$$L = \frac{166.6}{s} \text{ ft.}$$

Referring to the table for values of rh and $(w + t)$ in the above equations, the following values of L are obtained:

Ribbon No.	Equation (1)	Equation (2)
1	163.5	89.0
2	131.0	90.0
3	112.0	104.0
4	104.6	91.0
5	← 91.7 →	91.5
6	89.6	105.5
7	78.5	92.0
8	78.5	106.0
9	74.8	151.0
10	67.2	106.5

From this it appears that ribbon No. 5 is the most economical length to use in that it gives a minimum value for both equations (1) and (2). The length required is 91.6 ft. per phase and at 127 volts per phase, this length of No. 5 ribbon will dissipate 40 kw. at the desired thermal loading.

Liquid Level Indicator

The use of a small cyclometer to indicate liquor level gives more accurate measurements than may be obtained by the ordinary float indicators commonly used. To employ such a device only simple modifications in ordinary apparatus are required. The float rope or chain is arranged to drive several pulleys connected by round belting, or to drive a series of light gearing so as to step up the motion of the float to an amount depending upon the accuracy with which it is desired to know the level. To the shaft of the last pulley or gear a cyclometer is directly connected. The indicator is then easily calibrated. Since a small change in level will record a large change in the reading of this instrument, accurate control is made possible.

Coke Oven Gas Properties

By C. W. Stevens
Dayton, Ohio

It appeared in a study of the daily analyses of coke oven gas production that there was a distinct relationship between the constituents and the properties of the gas generated. Changes in operation, temperature, coking conditions, etc., seem to effect the gas properties in a definite relation. This is not difficult to comprehend. Changes in content of hydrogen, nitrogen, and other components of the gas affect the heat values and the specific gravities of the gas in ratio to the change, whether such changes be due to the carbonization process itself as effected by temperature, coking time and so on, or by outside air infiltration.

The curves show graphically these relations based upon a six months' record of daily analyses. During this time, there was no change in the coal used. It is evident that by use of the curves, such properties of the gas as calorific value and partial analysis can be determined quickly from the specific gravity, which latter is readily obtainable. As operating conditions give specific gas results, this also serves as a check on the operation of the plant. While results will differ somewhat from plant to plant, due to coal characteristics, these curves will give a rough indication of what may be expected, and will suggest the means for applying the idea in other plants.

Leaky Valve Detector

It was recently pointed out by F. Benjamin, writing in *Power*, that the ordinary lead pencil is an excellent detector for determining leaky valve seats and running down mysterious pounds. The unsharpened end of a pencil without a rubber eraser should be held snugly but not too firmly in the ear. The lead center is an excellent conductor of sound and when the point is placed against the valve in question will indicate even the slightest leak.

Steel Conveyor Screw

A cast iron screw conveyor used to move lump material against substantial back pressure gave trouble due to flight breakage. With insufficient time to procure a steel casting, an oxy-acetylene blowpipe used to rough a screw from a solid bar, saved many hours over what the entire operation on the lathe would have taken.

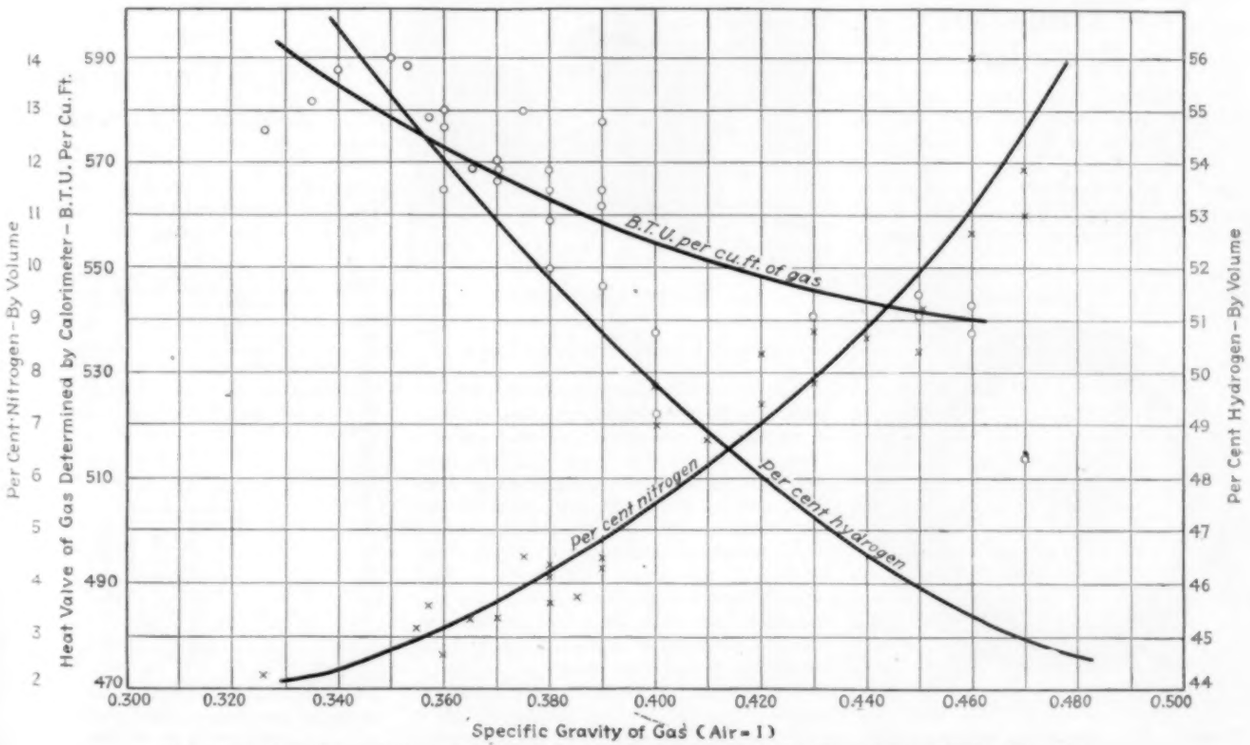


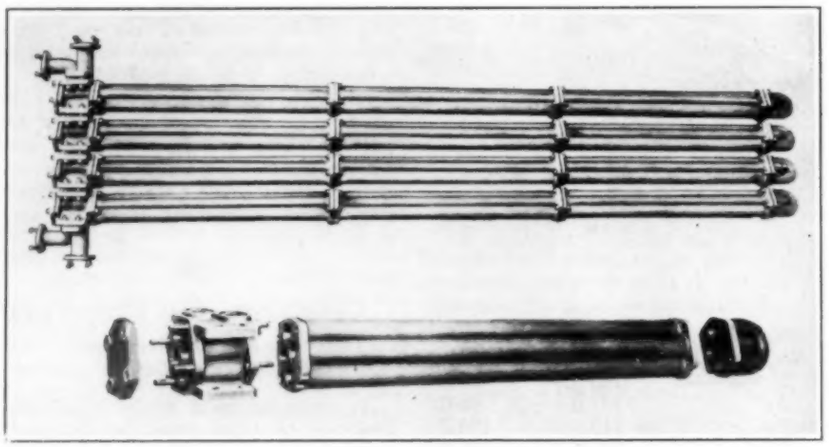
Chart Showing the Relations Between the Specific Gravity and the Properties of Coke Oven Gas

EQUIPMENT NEWS *from* MAKER *and* USER

Sectional Heat Exchanger

The Griscom-Russell Company, 285 Madison Ave., New York City, has placed on the market a new type of heat exchanger and cooler which has been called the G-R Tubeflo section. As is evident from the illustration, this heat exchanger has a number of features which adapt it especially for use under corrosive conditions.

The sections consist of semi-steel castings, each with four smooth cored passages for hot and cold fluids. The sections are interchangeable and may be bolted together in any desired number to give the proper length of fluid travel, or they may be arranged in parallel to give sufficient capacity. At one end of the assembly of sections is bolted a stationary head which contains the inlet and outlet connections, together with the necessary partitions for directing the flow of the fluid through the four chambers of the body pieces. At the opposite end of the sections, a floating bonnet forms a crossover connection between these passages. The exchangers are mounted so as to allow free movement of the body pieces of each section to permit unrestricted expansion and contraction. It is claimed that high fluid velocities may be used with resultant high heat-transfer rates.

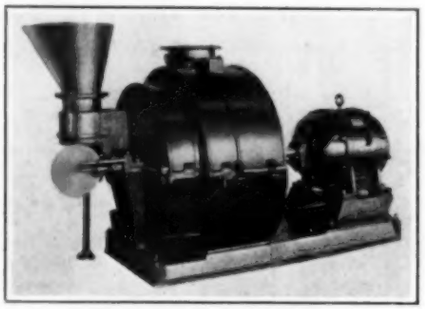


G-R Sectional Heat Exchanger
Three standardized and interchangeable types of parts may be combined to give any desired length of travel or any capacity.

New Temperature Recorder

A low-priced recording thermometer equipped with a 4-in., 72-hour chart is now being offered by the Bristol Company, Waterbury, Conn. The new model is self-contained. The case is of aluminum equipped with feet and a bail handle. The measuring element consists of a bi-metallic helix which is said to be positive in operation and extremely sensitive to temperature changes. The pen arm is attached directly to the measuring element and records without the aid of multiplying devices. The instrument may be supplied with a white enameled case if desired, although the standard finish is black.

Bristol's 4-In. Recording Thermometer



Warrior Unit Pulverizer

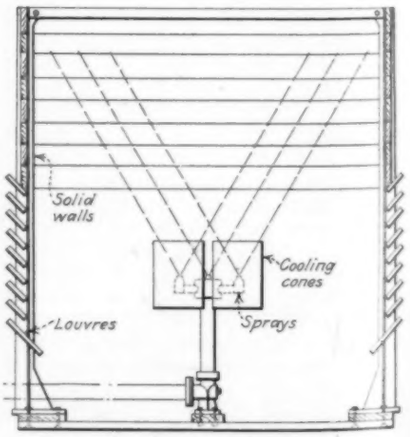
Unit Coal Pulverizer

The Fuel Efficiency Engineering Corporation, Birmingham, Ala., has recently announced a new series of coal pulverizers known as the Warrior Unit Pulverizers. The units are supplied in sizes from 200 to 15,000 lb. per hr. capacity, suitable for boilers of 100 hp. and greater. The units are designed for direct connection to the boiler or furnace. They consist of a 2-stage pulverizer, with automatic feed and delivery mechanism, directly driven by a motor or turbine mounted on the same base.

The coal is fed first into the first stage where it is beaten by hammers of a new design, then picked up by a current of air and conveyed to the second stage hammers where the air velocity is lowered so that only the finest particles are removed by the fan and sent with auxiliary air to the burner. The two hammer rotors and the fan are mounted on the same shaft which is carried on four Timken bearings. Special alloy steels are used for the hammers. The feeder mechanism is automatic and adjustable. The pulverizer is adapted to the use of preheated air where it is necessary to dry the coal during the pulverizing.

Small Unit Spray Cooling Tower

The Power Plant Equipment Company, Coca Cola Building, Kansas City, Mo., has announced the small unit type "Marley" spray cooling tower which is



Tower for Spray Cooling of Small Quantities of Water

especially adapted to ice plants, oil engines and similar installations where small quantities of water must be cooled continuously.

The tower is shown in the accompanying drawing. It occupies an area of 8 ft.x8 ft. and is 9 ft. tall. It is said to cool any quantity of water up to 100 gal. per minute.

The spray mechanism consists of four "Marley" nozzles mounted concentrically within open cylinders called "cooling cones." It is said that the upward flow of water induces an inward and upward flow of air through the cylinders thus improving the circulation of air within the tower.

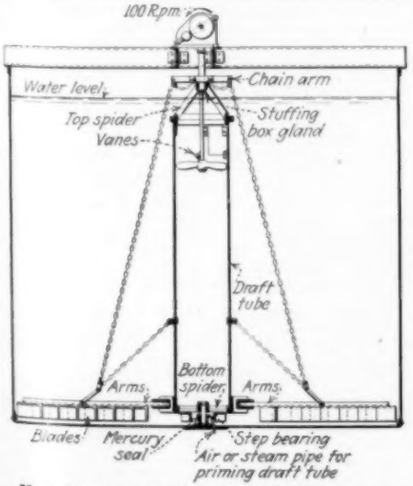
Fine Wire Cloth

What the makers claim to be the finest wire cloth ever produced is the 400-mesh screen which has been announced by the Newark Wire Cloth Co., Newark, N. J. The cloth with 160,000 square openings per sq.in., or 1,000,000 openings in a 2½-in. square, may be produced in all malleable metals ranging from steel, to platinum and gold. Heretofore the finest wire mesh produced is said to have been the 325-mesh cloth made by this company. Further information concerning the 400-mesh screen may be had upon application to the makers.

Impeller Agitator

A special modification of the Dorr reaction agitator known as the "Impeller Agitator" has been introduced to meet the needs of industries where agitation by means of air cannot be used for chemical reasons. This is a product of the Dorr Company, 240 Park Avenue, New York City.

The illustration shows the general construction of the new agitator. Through a combination two-speed speed reducer and a quill shaft, the vertical draft tube is driven slowly and a marine propeller located near the top and inside the tube is driven at a high rate of speed. Circulation of pulp is induced up the draft tube and down the annular space between the tube and the tank. Rakes which are suspended by chains from, and rotate with, the draft tube keep material which settles out, pushed in toward the center of the tank where the induced flow may pick it up and carry it through the draft tube. The tank and contents are thus given a general circulating movement in both the horizontal and the vertical planes.



New Forced Circulation Agitated Tank

Depending upon the tendency of the solids to segregate, design of the impeller portion of the agitator is varied to suit different materials. The agitator is said to be particularly adapted to continuous processes where agitation is ordinarily carried out by passing the material successively through three or more agitators, arranged in series on different levels. Power requirements for the apparatus are said to be very low, averaging one horse power for units of the usual 10 ft.x10 ft. size.

Large Vitreosil Pots

There is a definite need for fused silica pots or kettles large enough for batch production of chemical products. To meet this demand for equipment with maximum resistance to high temperature corrosion, the Thermal Syndicate, Ltd., 58 Schenectady Ave., Brooklyn, N. Y., has announced the development of Vitreosil pots in sizes up to 50 gal. These pots are available in quantity, and at prices said to compare favorably with enameled and alloy ware.

50 Gal. Fused Silica Pot

With the exception of hydrofluoric and phosphoric acids, the resistance of Vitreosil is equally great to all acids regardless of concentration or temperature, in contra-distinction to alloys. Its glassy, homogeneous structure is said to permit the use of this material at much higher temperatures than are possible with enamels.

The manufacturers point out that the introduction of these pots is noteworthy not only because of the inherent value of fused silica for severe service, but as well, because of the difficulties attendant upon the production of large articles from this material. It should be recalled that silica does not pass through any real liquid phase at high temperatures but must be manipulated in a semi-plastic condition at a temperature in the neighborhood of 2,200 deg. F.

Large Vitreosil pots are said to be especially useful as containers for reacting corrosive materials and for the mixing, melting, storing, cooking, evaporation, concentration and distillation of such products as chemicals, pharmaceuticals and fruit juices. Further information should be requested from the makers.

Armco Paved Invert Culvert

Erosion-Resisting Culvert

A bituminous coating applied to the lower or invert half of a culvert forms the basis of the new Paved Invert Culvert which is offered by the Armco Culvert Mfrs. Assn., Middletown, Ohio. This is shown in the accompanying photograph. The new culvert is said to be especially resistant to erosion as well as to the action of corrosive water such as is found about the chemical plant.

New Limit Switch

The General Electric Company, Schenectady, N. Y., has announced a new design of limit switch, suitable for controlling the limits of travel on such applications as motor-operated window- or door-opening apparatus, valves, or other equipment where magnetic control is used. This switch has been given the General Electric designation CR-9441-LS-424-A.

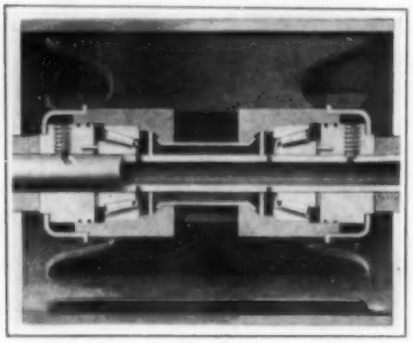
The switch is provided with two normally closed contacts, one for each extreme of travel. These contacts are operated by two cams, mounted on opposite faces of a molded gear. The two cams are adjustable with respect to each other and, as a further refinement, each contact has a micrometer screw which makes possible very close adjustment of the opening point for each contact after the general position of the cams has been set. The molded gear, with the two cams, is driven by means of a worm gear. The entire mechanism is inclosed in a cast-iron box with sheet-steel covers. Contacts are both of silver, thus insuring good contact regard-

less of oxidation, since silver oxide is a good conductor.

No tools are required for adjustment, and accurate fixing of the points at which the two cams will open their respective contacts is simple. Protection from live parts when making adjustments on the switch is insured by the use of molded insulation, making the switch suitable for use even by inexperienced operators.

Standard Conveyor Pulleys

The Jeffrey Manufacturing Co., Columbus, Ohio, announces that it has recently standardized on three types of pulleys for conveyor carriers. These will all fit the same stands and bases and



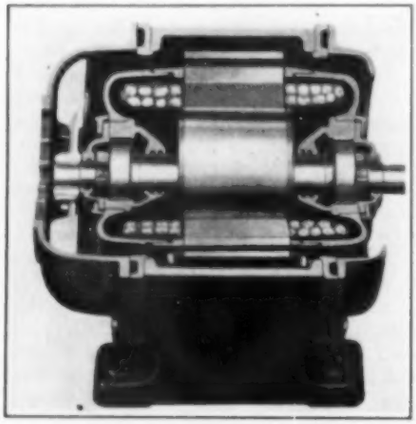
Anti-Friction Conveyor Pulley

differ only in the type of bearing used. The pulleys are of grey cast iron to resist corrosion and are made with open ends to prevent the collection of dust near the bearing ends.

The accompanying illustration shows the anti-friction type equipped with roller bearings. The other pulley types are equipped either with plain or bronze bushed bearings. All are adapted to receive grease under pressure through their hollow shafts, and are provided with ample lubricant reservoirs within the pulley hubs.

Fully Enclosed Motor

A recent development in the electric motor field is the announcement of a new totally enclosed and ventilated motor which has been brought out by the American Electric Motor Company of Cedarburg, Wis., a subsidiary of the Splitdorf-Bethlehem Electrical Company. This is known as the type P-K motor and is cooled by circulation of the air through, as well as over, the stator laminations. The stator core is perforated, and makes this possible. The air inside of the outer shell is agitated by malleable iron fans which are shrunk on the motor shaft.



Ventilated Dust-Tight Motor

Cage type ball bearings are provided. The latter are said to be fully protected from dust and dirt. The motors are available in the squirrel cage type, in ratings of from ½ to 60 hp. at a speed of 1,200 r.p.m.

Manufacturers' Latest Publications

Wellman-Seaver-Morgan Co., Cleveland, Ohio.—Bulletin No. 89—Covers Wellman "Supertest" Globe and Gate Valves.

Aluminum Bronze Mfrs. Institute, 810 Eighteenth St., Washington, D. C.—Booklet on "Technical Information on Aluminum Bronze."

American Platinum Works, New Jersey Railroad Ave. & Oliver St., Newark, N. J. —Catalog 15—Platinum Laboratory Wares.

Mine & Smelter Supply Co., Denver, Colo. —Catalog No. 73—Marcy Open End Rod Mills.

Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo.—Bulletin 151—A folder describing the new line of Wagner Air-Jacketed Motors.

Aldrich Pump Company, Allentown, Pa.—Data No. 70—Catalog with engineering data regarding single stage do ble-suction centrifugal pumps.

Palo Company, 153 West 23rd Street, New York City—A folder describing Palo apparatus for industrial and laboratory use.

The Superheater Company, 17 East 42nd Street, New York City.—A bulletin called "Elesco-operation," concerning Elesco service and superheaters.

Leeds and Northrup Co., 3901 Stenton Ave., Philadelphia, Pa.—Bulletin No. 497—Catalog describing the L & N Sugar Ash Bridge.

The Alloys Company, 121 Seventh St., San Francisco, Calif.—A reprint describing Merco pipe joint compound.

Alsop Engineering Co., 37 West 63rd St., New York City.—Catalog S-2—Folder covering "Hy-speed" syrup room equipment.

Hardinge Company, York, Pa.—Mailing pieces as follows: AH-109, Conical ball mills and spiral thickeners. AH-118, Conical ball mill unit pulverizer; AH-119, Unit coal pulverizer.

Staecey-Schmidt Mfg. Co., York, Pa.—Mailing piece on special equipment.

U. S. Colloid Mill Corp., 13th St. and East Ave., Long Island City, N. Y.—Folder announcing the new U. S. Junior Colloid Mill and Homogenizer.

Bird Machine Company, South Walpole, Mass.—Mailing piece describing the "Pulmax" Drive for short centers.

International Combustion Engineering Corporation, 200 Madison Ave., New York City:—Reprint from "World's Work," on "The Story of Combustion."

Combustion Engineering Corporation, 200 Madison Ave., New York City.—A paper by G. T. Ladd, on "Recent Developments in Steam Generation."

Wellman-Seaver-Morgan Company, Cleveland, Ohio.—Bulletin No. 90.—Catalog describing the Wellman Mechanical Double-Bell Fuel Feed for gas producers.

The Centripact Pulverizer Corporation, Patterson Building, Denver, Colorado.—A folder describing the Centripact Pulverizer.

Reeves Pulley Company, Columbus, Indiana—Bulletin T-4085—Announcing the new Reeves Variable Speed Transmission which is to be described in new bulletin No. 88.

General Electric Company, Schenectady, N. Y.—Publications as follows: GEA-137A, synchronous motors types TS and QS; GEA-147B, ratio adjusters; GEA-283A, A.C. small-plant and industrial switchboards; GEA-467A, CR-7022 automatic starters; GEA-582A, automatic switching equipment; GEA-797, commutator repairs; GEA-808A, "500 Series" totally inclosed fan-cooled induction motors; GEA-851, the electrification of the Mexican Railway; GEA-871, Diesel-electric drive for tankers; GEA-914, CR9441-LS424A, limit switch; GEA-916, electric apparatus for use with the Cottrell precipitation process; GEA-921, "Better lubrication"; GEA-927, portable recording instruments.

American Engineering Company, Philadelphia, Pa. — Catalog s-270-s — Describes the Taylor coal burning unit for boiler furnaces.

Chisholm-Moore Mfg. Company, Cleveland, Ohio.—Bulletin 31—Covers the electric hoists made by this manufacturer.

Niagara Smelting & Refining Corporation, Buffalo, N. Y.—Publications as follows: "How to Make Manganese Bronze," and a handbook, "1,001 Alloys Formulas," describing their properties and industrial application.

The Taber Pump Company, Buffalo, N. Y. —Bulletin M2-328—Folder describing the Taber Midget sump pump No. 2.

The American Rolling Mill Company, Middletown, Ohio,—"The Story of Armco," a booklet discussing the origin, development, aims, and policy of the American Rolling Mill Company.

Alexander Bros., 14 South Street, Philadelphia, Pa.—Catalog A-6—Engineering Information on "Pentacular" Transmissions.

Schutte and Koerting Company, Philadelphia, Pa.—Bulletin No. 4-P—Engineering data on water jet exhausters and compressors.

Clement K. Quinn & Company, Alworth Building, Duluth, Minn.—Booklet on 1928 analyses of Lake Superior iron ores.

Ajax Electrothermic Corporation, Ajax Park, Trenton, N. J.—Bulletin No. 5—Describes Ajax-Northrup electric furnaces of the coreless induction type.

National Flue Cleaner Company, Grovesville, N. J.—Form 30—Leaflet describing the National Soot Blower.

Struthers-Wells Company, Warren, Pa.—Circular No. 40—Describes the constructional details of the rotary driers, kilns and coolers made by this company.

Quigley Furnace Specialties Company, 26 Cortland St., New York City—Bulletin No. 201—Leaflet describing the application of the Quigley bitumen gun.

Globar Corporation, Niagara Falls, N. Y. —Reprint describing the Globar carborundum cartridge type heating element for electric furnaces.

Lincoln Electric Company, Cleveland, Ohio.—Bulletin No. 200-B—Describes the construction of Linc-Weld motors.

Electric Controller & Mfg. Company, Cleveland, Ohio.—Folder describing the unbreakable nickel alloy grid resistors made by this company.

Brown Instrument Company, Philadelphia, Pa.—Reprint describing the savings made by the use of pyrometers.

International Nickel Company, 67 Wall St., New York City.—Two reprinted articles: "Roller Bearings in Railroad Service" and "Nickel Alloy Steels for Roller Bearings."

Sangamo Electric Company, Springfield, Ill.—Supplement to bulletin No. 67—Describes Sangamo type HC watt-hour meters.

Crouse-Hinds Company, Syracuse, N. Y. —Bulletin 2106, "Floodlights and Industrial Units," Bulletin 2109, "Floodlighting."

DeLaval Steam Turbine Company, Trenton, N. J.—Folder on "DeLaval Pumps at Wenatchee, Washington."

LaMont Corporation, 200 Fifth Ave., New York City.—Pamphlet describing "LaMontube" water screens for furnaces.

Driver-Harris Company, Harrison, N. J.—Folder concerning Nichrome castings.

Allis-Chalmers Mfg. Company, Milwaukee, Wis. — Bulletin 1118-E — Booklet describing the construction of type AR and ARY polyphase induction motors.

Semet-Solvay Engineering Corporation, 40 Rector St., New York City—Publications as follows: Pamphlet 330, Steere sleeve joints; bulletin 331, the Backrun process; bulletin 335, Steere steel pipe.

Silent Hoist Winch & Crane Company, 762 Henry St., Brooklyn, N. Y.—Bulletin No. 27—Bulletin describing all of the types of hoisting equipment made by this company.

Chicago Bridge & Iron Works, 337 W. VanBuren St., Chicago, Ill. — "Stopping Evaporation and Fire," a catalog completely describing the Wiggins floating roof.

The Swenson Evaporator Company, Harvey, Ill.—Announcement of a series of practical articles on "Heat Transfer and Crystallization." The series consists of ten articles written by Prof. W. L. Badger, and will be issued at intervals of approximately one month. These bulletins will be available for distribution upon request.

PATENTS ISSUED
Mar. 6 to Mar. 27, 1928

Paper, Pulp, Glass and Sugar

Apparatus for Pulp-Board Making. Herbert Theodore Price, Burwood, Sydney, New South Wales, Australia.—1,661,678.

Paper Making. Charles Neal Merrill, Millinocket, Me., assignor to Great Northern Paper Company, Millinocket, Me.—1,662,200. *To preserve continuity of sheet.*

Paper Pulp and Like Beating Engine. Samuel Milne, Edinburgh, Scotland.—1,662,466.

Paper-Making Machine. Herman L. Kutter, Hamilton, Ohio, assignor to The Black-Clawson Company, Hamilton, Ohio.—1,662,929.

Decolorizing Carbon and Process of Making Same. Charles Hallsteam Chandler, Newport, R. I.—1,663,000. *Sugar cane pith.*

Manufacture of Glass Tubing and Cane. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn.—1,663,093.

Process of Making Structural Insulating Boards of Exploded Ligno-Cellulose Fiber, etc. William H. Mason, Laurel, Miss., assignor to Mason Fibre Company, Laurel, Miss.—1,663,503, 1,663,506.

Process for Sizing Paper. Thomas Hans, Chicago, Ill., assignor to Container Corporation of America, Chicago, Ill.—1,662,641.

Glass Furnace. Thomas B. Hart, Libow, W. Va., assignor of one-half to Blackford Window Glass Company, Vincennes, Ind.—1,663,839.

Glass-Feeding Mechanism. Theodore C. Steimer, deceased, Pittsburgh, Pa., by Charles M. Steimer, executor, Zanesville, Ohio, assignor, by mesne assignments, to Hartford-Empire Company, Hartford, Conn.—1,663,925.

Method of Sizing Paper. Judson A. De Cew, New York, N. Y.—1,663,976.

Rubber, Rayon and Synthetic Plastics

Manufacture of Compositions or Preparations With Cellulose Derivatives. Henry Dreyfus, London, England. — 1,661,169. *Acetate.*

Process for Treating Rubber With Aldehyde Derivatives and Products. Sidney M. Cadwell, Leonia, N. J., assignor to The Naugatuck Chemical Company, Naugatuck, Conn.—1,662,182. *For retarding deterioration.*

Process for Treating Cellulosic Material. Frederick Carl Niederhauser and Hayden Benamin Kline, Cleveland, Ohio, assignors to The Industrial Rayon Corporation, Cleveland, Ohio.—1,661,574. *Evenness in drying.*

Apparatus for Grinding or Comminuting Rubber and Other Materials. Charles Edward Gardner, Gloucester, England.—1,661,721.

Process for Reducing the Viscosity of Nitrocellulosic Materials. Chauncey U. Prachel, Rochester, N. Y., assignor to Eastman Kodak Company, Rochester, N. Y.—1,661,736.

Method of and Means for Preserving Vulcanized Rubber. Hans Werner Fiedler, Leipzig, Germany.—1,661,887.

Method of and Means for Continuously Vulcanizing Rubber Stock. George Frederick Fisher, Roselle, N. J.—1,661,888.

Apparatus for the Manufacture of Artificial Silk. Friedrich Wilhelm Schubert, Apperley Bridge, near Bradford, England, assignor to Brysilka, Limited, Apperley Bridge, near Bradford, England.—1,662,478. *Cupra-ammonium.*

Method of and Apparatus for Vulcanizing. Conrad Dressler, New York, N. Y., assignor to American Dressler Tunnel Kilns, Inc., New York, N. Y.—1,662,804.

Composition for Use in Forming Rubber and the Like. James M. Cranz, Buffalo, N. Y., assignor to The Rubber Service Laboratories Company, Akron, Ohio.—1,662,958.

Coating Composition Containing Rubber and Drying Oils and Method of Making Same. Charles M. Stine, Wilmington, Del., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,663,100.

Coating Composition and Process of Making the Same. Cole Coolidge, Wilmington, Del., and Herbert E. Eastlack, Parlin, N. J., assignors to E. I. du Pont de Nemours & Company, Wilmington, Del. — 1,663,119. *Rubber composition for paint.*

Method of Making Lacquers. Kurt Schmidinger, Neukolln, Germany.—1,663,733.

Coating and Impregnating Medium. Carleton Ellis, Montclair, N. J.—1,663,160. *Phenol-sulfurhalide resin.*

Rubber Filter Sheet. William C. Geer, Akron, Ohio, and Charles F. Sherwood, San Francisco, Calif., assignors to The B. F. Goodrich Company, New York, N. Y.—1,663,298.

Colored Vulcanized Rubber and Process of Making the Same. Ernest R. Bridgwater, Wilmington, Del., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,663,436.

Process for the Manufacture of a Cellulose Product Having the Appearance of Wool. Augustin Pellerin, Trouville, France.—1,664,319.

Petroleum Refining and Products

Process for Controlling Destructive Distillation of Petroleum Oil. Richard W. Hanna, Piedmont, Calif., assignor, by mesne assignments, to Universal Oil Products Company, Chicago, Ill.—1,658,241.

Apparatus for Treating Oils. George D. Sims, Independence, Kan., assignor to Universal Oil Products Company, Chicago, Ill.—1,658,420.

Apparatus for the Conversion of Hydrocarbon Oils. Eric T. Hessle and Willy Leigemann, Lockport, Ill.—1,658,985.

Apparatus for Treating Hydrocarbons. Gustav Egloff and Harry P. Benner, Chicago, Ill., assignors to Universal Oil Products Company, Chicago, Ill.—1,659,397.

Method of and Apparatus for Separating Oils. John Kellar Pierce, Fort Worth, Tex., assignor of one-half to William S. Pierce, Murphy, N. C.—1,660,235.

Distillation of Hydrocarbons. Merle R. Meacham, Elizabeth, N. J., assignor to Standard Oil Development Company.—1,661,189.

Apparatus for Cracking Oil. Royal S. Pershing, Fort Worth, Tex.—1,661,196.

Process for the Conversion of High-Boiling Hydrocarbons into Low-Boiling Hydrocarbons. Lazar Edeleanu, Berlin-Charlottenburg, Germany, assignor to Allgemeine Gesellschaft fur Chemische Industrie, Berlin, Germany.—1,661,565.

Motor Fuel and Process of Refining Oils. Lazar Edeleanu, Berlin-Charlottenburg, Germany, assignor to Allgemeine Gesellschaft fur Chemische Industrie, Berlin, Germany.—1,661,566.

Apparatus for Treating Oil. Frederick A. Kormann, New Rochelle, N. Y., assignor to United Refineries Company, New York.—1,661,804.

Continuous Process for the Refining of Mineral Oils. Eric Th. Hesslé, Lemont, Ill.—1,661,826.

Process and Apparatus for Distilling Oil. Henry L. Doherty, New York, N. Y., assignor, by mesne assignments, to Heat Treating Company, New York, N. Y.—1,662,105.

Motor Fuel. Thomas Midgley, Jr., Dayton, Ohio, assignor to General Motors Corporation, Detroit, Mich.—1,662,323. *Anti-knock.*

Oxidation of Hydrocarbon Oils. Ebenezer Emmet Reid, Baltimore, Md., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,663,523.

Bituminous Emulsion. Henry R. Gundlach, Baltimore, Md., assignor to Thomas Oil By-Products Company.—1,663,652.

Art of Cracking Hydrocarbons. George H. Taber, Jr., Rye, N. Y., assignor to Sinclair Refining Company, New York, N. Y.—1,663,868.

Cracking Oils. Franz Puening, Pittsburgh, Pa.—1,664,263.

Coal Processing and Furnaces

Method for the Dry Cooling of Coke. Reinhard Wussow, Charlottenburg, Berlin, Germany.—1,661,211.

Gas-Analyzing Apparatus. Olof Rodhe, New York, N. Y., assignor to Svenska Aktiebolaget Mono, Stockholm, Sweden.—1,661,627.

Gas-Producing Apparatus. Vincent D. McDonnell, Chicago, Ill.—1,662,266.

Gas Retort. Heinrich Koppers, Essen-Ruhr, Germany, assignor to The Koppers Development Corporation, Pittsburgh, Pa.—1,663,847.

Organic Processes

Method for Treating Lactic Fluids. Joseph Moses Ward Kitchen, East Orange, N. J.—1,658,168.

Glue and Process of Producing Glue from Casein. George Lanzendorfer, Braintree, Mass., assignor to Marstin Adhesive Company, Boston, Mass.—1,659,271.

Explosive Composition. Walter O. Snelling and Guy A. Rupp, Allentown, Pa., assignors to Trojan Powder Company, New York, N. Y.—1,659,449.

Method of Producing Commercial Stearic Acid. Joel Starrels, Chicago, Ill.—1,659,790.

Process for the Preparation of New Derivatives of Naphthoquinone. André Wahl, Enghein, and Robert Lantz, Paris, France, assignors of one-half to Societe Anonyme des Matieres Colorantes et Produits Chimiques de Saint-Denis, Paris, France.—1,657,809.

Process of Making Anilides. Edward A. Nill, Cleveland, Ohio, assignor of one-third to Frederick C. Acker, Cleveland Heights, Ohio, and one-third to James R. Dall, Norwalk, Ohio.—1,659,150.

Apparatus for the Production of Formol by Catalysis. Emile Augustin Barbet, Paris, France.—1,661,063.

Production of Aromatic Ketonic Compounds. Frederick H. Kranz, Buffalo, N. Y., assignor to National Aniline & Chemical Co., Inc., New York, N. Y.—1,661,293.

Process for the Manufacture of New Organic Arsenic Compounds. Johannes Pfleger, Frankfort-on-the-Main, and August Albert, Munich, Germany.—1,661,301.

Process of Making Tetra-Alkyl Lead. Kenneth P. Monroe, Penns Grove, N. J., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,661,809.

Production of Primary Amines. Paul Herold and Paul Koppe, Neurossen, Germany, assignors to Grasselli Dyestuff Corporation, New York, N. Y.—1,662,421.

Treatment of Cellulosic Materials. Denis de Göncz, North Adams, Mass., assignor to Arnold Print Works, North Adams, Mass.—1,661,879.

Method of Preparing Thiazoles. Lorin B. Sebrell and Jan Teppema, Akron, Ohio, assignors to The Goodyear Tire & Rubber Company, Akron, Ohio, a Corporation of Ohio.—1,662,015.

Method of Sublimation. Crosby Field, Mahwah, N. J., assignor to National Aniline & Chemical Co., Inc., New York, N. Y.—1,662,056.

Process of Making Indophenols. Ray W. Hess, Buffalo, N. Y., and Orin D. Cunningham, Indianapolis, Ind., assignors to National Aniline & Chemical Co., Inc., New York, N. Y.—1,662,062.

Sublimation Apparatus. Chauncey A. Lyford, East Aurora, N. Y., assignor to National Aniline & Chemical Co., Inc., New York, N. Y.—1,662,070.

Process for Concentrating Formaldehyde Solutions. Adolph Zimmerli, New Brunswick, N. J.—1,662,179.

Production of Beta-Naphthol-1-Sulphonic Acid. Alfred E. Parmelee, Carneys Point, N. J., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,662,396.

Process for the Manufacture of Diphenylguanidine. Harold S. Adams and Ludwig Meuser, Naugatuck, Conn., assignors to The Naugatuck Chemical Company.—1,662,626.

Process of Bleaching Animal and Vegetable Materials. Alfred O. Bragg, Niagara Falls, N. Y., assignor to International Bleaching Cororation.—1,662,951.

Guanidine Compound. Ralph V. Heuser, Elizabeth, N. J., assignor to American Cyanamid Company, New York, N. Y.—1,663,128.

Process for the Recovery of Volatile Solvents. Jean Henry Brégeat, Paris, France.—1,663,155.

Phthalic Anhydride-Glycerol Resins and Process of Preparing Same. John H. Schmidt, Chicago, Ill., assignor to Bakelite Corporation, New York, N. Y.—1,663,183.

Organic Mercury Compound. Edward Lyons, Detroit, Mich., assignor to Parke, Davis & Company, Detroit, Mich.—1,663,205.

Preparation of Levulose from Purified Dahlia Juice. William C. Arsem, Schenectady, N. Y., assignor to Industrial Technics Corporation, Schenectady, N. Y.—1,663,233.

Production of Emulsions. Wilfred Ambrose Whatmough, Finchley, England.—1,663,323. *Oil-water, by treatment with oleic acid, etc.*

Method of Producing Acetone. Koloman Róka, Konstanz, Germany, assignor to Holzverkohlungs-Industrie A. G., Konstanz, Germany.—1,663,350. *From ethyl alcohol and water vapor.*

Process of Producing Aromatic Amines. Clark W. Davis, Chester, Pa., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,663,476.

Process of Making Rosin Soap. Carl C. Kesler, Pittsburgh, Pa., assignor to Pine Institute of America, Incorporated, Jacksonville, Fla.—1,663,764.

Process for Treating Printed or Dyed Fabrics. Raymond W. Jacoby, Forest Hills, N. Y., assignor to The Deltex Co.—1,663,845.

Dyestuffs of the Triphenyl Methane Series. Ottmar Wahl, Leverkusen, Germany, assignor to Grasselli Dyestuff Corporation, New York, N. Y.—1,663,869.

Process of Manufacturing Tetraethyl Lead. William S. Calcott, Penns Grove, Alfred E. Parmelee, Carneys Point, and Frederick B. Lorriman, Penns Grove, N. J., assignors to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,664,021.

Paint. Leslie Milton Wise, McKeesport, Pa.—1,664,341. *Acetylene byproduct.*

Inorganic Processes

Process of Desulphidizing and Desulphurizing Sulphur Minerals. Melville Fuller Coolbaugh and John Burns Read, Golden, Colo., assignors to The Complex Ores Recoveries Company, Denver, Colo.—1,657,711.

Catalytic Oxidation of Sulphur Dioxide. Alphons O. Jaeger and Johann A. Bertsch, St. Louis, Mo., assignors to Selden Company, Pittsburgh, Pa.—1,657,753.

Catalytic Oxidation of Sulphur Dioxide. Alphons O. Jaeger and Johann A. Bertsch, St. Louis, Mo.—1,657,754.

Process and Device for the Purification of Hard Water by Base-Exchanging Bodies. Emile Marcel, Eugène Fréchou, Paris, France.—1,657,822.

Process for Collecting Phosphoric Acid. Bethume G. Klugh, Anniston, Ala., assignor to Federal Phosphorus Company, Birmingham, Ala.—1,659,146.

Process for Making Sodium Monosulphite. Viggo Drewsen, Larchmont, N. Y., assignor to West Virginia Pulp & Paper Company, New York, N. Y.—1,659,193.

Method of and Apparatus for Making Carbon-Dioxide Snow. James W. Martin, Jr., Yonkers, N. Y., assignor to Dryice Corporation of America, New York, N. Y.—1,659,435.

Process of Hardening and Aging Calcined Gypsum Products. James H. Colton, Berkeley, Calif., assignor to Pacific Portland Cement Company, Consolidated, San Francisco, Calif.—1,659,971.

Prepared Calcium Chloride and Method of Making Same. Albert Kelvin Smith, Midland, Mich., assignor to The Dow Chemical Company, Midland, Mich.1,660,053.

Process for the Production of Silicon Carbide and Calcium Carbide. Harold E. White, Anniston, Ala., assignor to Federal Abrasives Company, Birmingham, Ala.—1,660,144.

Copper Refining. Anthony G. de Golyer, Brooklyn, N. Y.—1,660,220.

Nitration Process. John Marshall, Swarthmore, Pa., and Frank H. Bergeim, Woodbury, N. J., assignors to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,660,651.

Process for the Rapid Evaporation to Dryness of Ammonium-Nitrate Solutions. Carlo Toniolo, Milan, Italy.—1,661,203.

Process of Refining Light Metals Such as Magnesium or Aluminum or Their Alloys and Recovering Such Metals from Scrap. Adolf Beck, Bitterfeld, Germany, assignor to the Firm I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany.—1,661,526.

Manufacture of Anhydrous Magnesium Chloride. Robert Griessbach, Ludwigshafen-on-the-Rhine, and Kurt Röhre, Mannheim, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany.—1,661,894.

Bromine Recovery. James P. Andrew, Detroit, Mich., assignor by mesne assignments, to General Motors Corporation, Detroit, Mich.—1,662,355. *From saline solutions.*

Bromine Recovery. Graham Edgar, Dayton, Ohio, assignor to Ethyl Gasoline Corporation, Dayton, Ohio, a corporation of Delaware.—1,662,305. *From saline solutions.*

Phosphorus Material. Harry Williams Charlton, New York, N. Y., assignor to American Cyanimid Company, New York, N. Y.—1,662,489. *Preparation of compounds.*

Sulphur Fungicide and Insecticide. Cornelius D. Vreeland, Vineland, N. J.—1,662,550.

Concentration of Barite. Walter O. Borcherdt, Austinville, Va., assignor to The New Jersey Zinc Company, New York, N. Y.—1,662,633.

Method of Heat Treatment of Alumina and Other Materials. Thomas S. Curtis, Huntington Park, Calif., assignor, by mesne assignments, to Pacific-Southwest Trust & Savings Bank, trustee, Los Angeles, Calif.—1,662,739.

Process of Making Alkali-Metal Sulphydrates. Harry P. Bassett, Cynthiana, Ky.—1,662,735.

Hydrating Unit. Hugh Miscampbell, Duluth, Minn.—1,662,932. *For lime.*

Method of Treating Calcium Cyanide. Palmer W. Griffith, Elizabeth, N. J., assignor to American Cyanamid Company, New York, N. Y.—1,663,125.

Process for Purifying and Bleaching Heavy Spar. Karl Ebers, Ahrensburg, Germany.—1,663,159.

Method of Producing Basic Aluminum Sulphate and the Product Thereof. Donald B. Bradner, Edge Moor, Del., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,663,435.

Method of Oxidizing Ammonia by Means of Oxygen. Frans Georg Liljenroth, Stockholm, Sweden.—1,663,914.

Copies of Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Photostatic copies of foreign patents may be obtained at the same address, prices on application.

Process for the Production of Hydrofluoric Acid from Fluoric and Silicic Substances. Max Buchner, Hanover-Kleefeld, Germany, assignor to Albert Fritz Meyerhofer, Zurich, Switzerland.—1,664,348.

Process of and Apparatus for Isolating Argon. Gorton R. Fonda, Schenectady, N. Y., assignor to General Electric Company.—1,664,205.

Chemical Engineering Processes and Equipment

Valve. William J. Mead, Galveston, Tex.—1,661,190.

Tank-Car Siphon Valve. Edwin S. Thayer, Oakdale, Pa.—1,661,202.

Grinding Pan. Walter Earl McMurray, Clearfield, Pa., assignor to Clearfield Machine Company, Clearfield, Pa.—1,661,297.

Refractory Muffler. Charles W. Saxe, Worcester, Mass., assignor to Norton Company, Worcester, Mass.—1,661,309.

Liquid-Treating Apparatus. Harvey H. Miller, Canton, Ohio, assignor to The H. H. Miller Industries Company, Canton, Ohio.—1,661,379. *Vat, with spraying device.*

Process of Separating Liquids. Oscar L. Barnebey, Cleveland, Ohio, assignor to American Solvent Recovery Corporation.—1,661,403.

Apparatus for Concentrating Aqueous Liquids. Pierre Jerome de Saint André Meynardie, Paris, France.—1,661,489.

Separating or Classifying Machine. William A. Riddell, Frederick, Md.—1,661,501.

Water Softener. Victor C. Norquist, Kansas City, Mo.—1,661,675.

Electric Resistance Furnace Adapted for Heating by Nitrogenization. Adolf Fry, Essen-on-the-Ruhr, Germany, assignor to Fried. Krupp Aktiengesellschaft, Essen-on-the-Ruhr, Germany.—1,661,694.

Process for Reclaiming Used Lubricating and Insulating Oils. Archibald F. Meston, Poughkeepsie, N. Y., assignor to The De Laval Separator Company, New York, N. Y.—1,661,731.

Catalytic Apparatus. Eric Th. Hesslé, and Willy Leigemann, Lemont, Ill.—1,661,827.

Apparatus for Firing Ceramic and Other Products. Charles T. Holcroft, Detroit, and Charles E. Doll, Mount Clemens, Mich.—1,662,063.

Evaporator and Method of Operation. Carl F. Braun, San Francisco, Calif.—1,662,142. *Distillation.*

Heat-Exchange Apparatus. Carl F. Braun, Pasadena, Calif.—1,662,143.

Apparatus for and Method of Treating Fluids. John P. Ball, Chicago, Ill.—1,662,180.

Continuous Press. Edgar T. Meakin, Berkeley, Calif.—1,662,531.

Heater or Cooler. Daniel Raymond McNeal, Palmyra, N. J., assignor to Andale Engineering Company.—1,662,615.

Liquid-Treating Apparatus. Hugo Berquist, Swissvale, Pa., assignor to William S. Elliott, Pittsburgh, Pa.—1,662,630. *Removal of dissolved gases.*

Process for Treating Flue Dust. Kenneth M. Simpson, New York, N. Y.—1,661,636.

Heat Treatment of Materials for Distilling, Drying, or Carbonizing Them. Arthur McDougall Duckham, Douglas Rider, and John Simkins Watts, London, England.—1,662,663.

Decanter. John C. Hebden, New York, N. Y., assignor to Hebden Sugar Process Corporation, New York, N. Y.—1,662,702.

Filtering Apparatus. Jean Baptiste Vernay, Villeurbanne, France.—1,662,726.

Grooved-Plate Heat Interchanger. Cecil W. Stancliffe, Stamford, Conn., assignor to Stancliffe Engineering Corporation, New York, N. Y.—1,662,870.

Valve. Sven Johan Nordstrom, San Francisco, Calif., assignor to Merco Nordstrom Valve Company, San Francisco, Calif.—1,662,892.

Pipe Joint. Benjamin Broido, New York, N. Y.; Anna G. Freedman Broido and The National City Bank of New York, administrators of Benjamin Broido, deceased.—1,662,954.

Control System for Refrigerating Apparatus. Emory S. Ensign, New Haven, Conn., assignor to National Refrigerating Company, New Haven, Conn.—1,662,965.

Conveyer Roller. George W. Curtis, Canton, Ohio, assignor to The Timken Roller Bearing Company, Canton, Ohio.—1,663,003.

Tunnel Kiln. Halver R. Straight, Adel, Iowa.—1,663,029.

Process of and Apparatus for Controlling the Movement of Masses of Solids of Various Sizes. Louis E. W. Pioda, San Francisco, Calif.—1,663,173. *Vented hopper.*

Heat Interchanger. Edward B. McCabe, Carbondale, Pa., assignor to Carbondale Machine Company, Carbondale, Pa.—1,663,209.

Apparatus for Producing Clay Products. Matthew Lang, Akron, Ohio.—1,663,309. *Kiln.*

Apparatus for Elevating Fluids. Lester H. Miles, Los Angeles, Calif.—1,663,311.

Endless Belt Conveyer. Thomas Caygill Lennard, Glasgow, Scotland.—1,663,344.

Treatment for Hides and Skins. Harry Dodge, Danvers, Mass.—1,663,401.

Separator. William M. Little and Jessie L. Sherman, Norphlet, Ark.—1,663,411.

Metal-Cleaning Solution. Clarence F. Dinley, Detroit, Mich., assignor to Rex Products & Manufacturing Company, Detroit, Mich.—1,663,446.

Gas-Cleaning Apparatus. Charles Gilbert Hawley, Chicago, Ill., assignor to Centrifix Corporation, Cleveland, Ohio.—1,663,597. *Centrifugal cleaner.*

Device for Separating Liquids of Different Specific Gravities. Edward William Green, London, England.—1,663,651. *Gravity settling.*

Pipe Coupling. William D. Himes, Los Angeles, Calif., assignor to Los Angeles Manufacturing Company, Los Angeles, Calif.—1,663,702.

Centrifugal Machine. Victor Redlich, Vienna, Austria.—1,663,731.

Apparatus for Treating Gases. Eugen Ströder, Leverkusen, near Cologne, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany.—1,663,734.

Centrifugal Grinding Mill. William A. Gibson and James G. Burke, Allentown, Pa., assignors to Bradley Pulverizer Company, Allentown, Pa.—1,663,881.

Condenser. Forrest L. Bryant, Binghamton, N. Y.—1,663,995.

Evaporator Protector. Carl William Schedler, Berkeley, Calif.—1,664,133.

Vapor Tower. Harry Ashley Wier, Dallas, Tex.—1,664,237.

Filtering Device. Arthur P. Hall, West Newton, Mass.—1,664,252. *Series gravity filter.*

Method of Preparing Filtering Materials. Friedrich Hermann Weil, Kreuznach, Germany, assignor to Seitz-Werke G. m. b. H., Kreuznach, Germany—1,664,275. *Asbestos filter.*

NEWS *of the Industry*

A.C.S. Meeting In Progress at St. Louis

THE seventy-fifth meeting of the American Chemical Society was opened at St. Louis on Monday, April 16. The meeting will close on April 19.

Following the registration of delegates at the Hotel Chase, the meeting of the Society's Council opened on Monday afternoon, April 16, presided over by the president of the society, Dr. S. W. Parr.

Tuesday and Wednesday will be devoted to divisional meetings, at which reports and addresses dealing with many fields of chemical science will be made. A general public meeting will be held on Tuesday evening at 8:00 p.m. Dr. William J. Mayo of Rochester, Minn., will speak on "The Advancement of Learning in Medicine Through Biochemistry" at a group dinner at 6:30 p.m. on Wednesday.

The progress of the rubber chemist will be described at three-day sessions of the Rubber Chemistry Division, of which H. L. Fisher of New York is chairman.

Thirty papers dealing with the biochemistry of soils, nutrition, vitamins, ultra-violet irradiations, endocrinology, and the relation of chemistry to health and disease, will be presented before the Division of Biological Chemistry, of which H. E. Howe of Washington, D. C., is chairman.

The Agricultural and Food Chemistry Division will hold a symposium on insecticides and fungicides under the chairmanship of Dr. R. C. Roark of the Bureau of Chemistry and Soils, Department of Agriculture, Washington.

The Division of Chemical Education, headed by Prof. B. S. Hopkins of the University of Illinois, will hold sessions lasting four days, and including a symposium on analytical chemistry, Tuesday, April 17. Many prominent chemistry educators will speak.

The Division of Industrial and Engineering Chemistry, of which R. J. McKay of New York is chairman, will take up lubrication, filtration, and equipment construction. Among the speakers will be R. E. Wilson, assistant director of research and chemical engineer of the Standard Oil Company of Indiana; D. R. Sperry, director of D. R. Sperry and Company, North Aurora, Ill., and W. T. Read, head of the Department of Chemistry at Texas Technical College, Lubbock, Texas.

At a meeting of the Division of Water, Sewage, and Sanitation, of which S. E. Coburn of Boston is chairman, these subjects will be discussed: "Treatment of Water for Railroad Use," "Recent Advances in the Softening of Municipal Water Supplies," "Softening of Water in the Home," and "Phases of the Utilization of Colorado River Water in View of the New Data on the Dissolved Mineral Matter and Silt Carried by the River."

New Formulas Announced for Denaturing Alcohol

THE Commissioner of Prohibition, Dr. J. M. Doran, announced the promulgation April 7 of an amendment to Regulations 3 by which alcohol denatured under any of three different formulas may not be withdrawn for use in leather processing after May 1. Instead of the three formulas now in use, the Commissioner has decided to permit withdrawal of alcohol denatured under three other formulas heretofore prohibited for use in the leather trades.

Following is the full text of the amendment: Effective May 1, 1928 Specially Denatured Alcohol Formulas Nos. 2-A, 2-B and 12-A can no longer be withdrawn for use in the manufacture of patent leather, artificial leather, leather finishes, thinners, solutions and solvents used in the leather industry and solvents of any kind except ethyl acetate and similar esters.

Specially denatured Alcohol Formulas Nos. 1, 23-A and 44-A are hereby authorized for use in the manufacture of the above mentioned products in lieu of Specially Denatured Alcohol Formulas Nos. 2-A, 2-B and 12-A.

Potassium Permanganate Up for Public Hearing

THE U. S. Tariff Commission has set April 19 as the date for a public hearing in the pending investigation of the costs of production for potassium permanganate. The hearing is scheduled for the morning of April 19 at the office of the commission in Washington. This is in connection with a petition for an increase of 50 per cent in the import duty as provided for by the flexible provisions of the Tariff act. A preliminary investigation has been completed and the commission has issued a statement of information for the use of interested parties in the investigation.

Imperial Chemical Joins Chase Interests

ALBERT H. WIGGIN, chairman of the board of the Chase National Bank, issued a statement on April 12 confirming reports from London regarding the formation of The Finance Company of Great Britain and America, Limited, jointly by the Imperial Chemical Industries, Limited, and the Chase National Bank interests.

The company has been formed with an initial capital of £2,000,000 all of which has been subscribed by the Imperial Chemical Industries, Limited, and by the Chase interests, jointly.

The company is formed for the purpose of providing facilities for commercial and industrial financing in the British Empire, Europe and the United States, in co-operation between English and American interests.

The participation of the Chase interests in this joint enterprise is in line with their recently announced policy of expanding their foreign business and their contracts in foreign industrial centers.

Sir Alfred Mond, chairman of the Imperial Chemical Industries, Limited, and many other industrial concerns and also a director of the Westminster Bank, Limited, will be chairman of the board of directors of the new company, and Sir Henry McGowan, chairman and managing director of Nobel Industries, Limited, will be the vice-chairman of the board of the new company.

Mr. Wiggin will be chairman of the American committee. In addition, the American committee will include the following: Matthew C. Brush, president and chairman of the executive committee of American International Corporation; Frederick H. Ecker, vice-president Metropolitan Life Insurance company; Archibald R. Graustein, president International Paper Company; J. Horace Harding, of Charles D. Barney and Company; John J. Raskob, vice-president and chairman of the finance committee of General Motors Corporation; Charles M. Schwab, chairman of the board of directors of Bethlehem Seteel Corporation; Alfred P. Sloan, Jr., president of the General Motors Corporation; William H. Woodin, president of American Car and Foundry Company and Halstead G. Freeman, president of Chase Securities Corporation.

Supreme Court Upholds Tariff Act

THE Supreme Court upheld all phases of the flexible provisions of the Tariff act in a decision rendered April 9.

The decision, read by Chief Justice Taft, was given in the case of J. W. Hampton, Jr., & Co. of New York, who had protested an increase of 4c. to 6c. in the duty on barium dioxide, made effective under the flexible tariff section.

The importers argued that the section is invalid in that it is a delegation to the President of the legislative power vested under the Constitution exclusively in Congress and because it was enacted with the avowed intent and for the purpose of protecting the industries of the United States. It was explained in this regard that the Constitution gives power to lay such taxes only for revenue.

As to the right of Congress to use executive officers or commissions to carry out the effects of legislative action, Chief Justice Taft's opinion said:

"The field of Congress involves all and many varieties of legislative action, and Congress has found it frequently necessary to use officers of the executive branch within defined limits to secure the exact effect intended by its acts of legislation by vesting discretion in such officers to make public regulations interpreting a statute and directing the details of its execution, even to the extent of providing for penalizing a breach of such regulations.

"Congress may feel itself unable conveniently to determine exactly when its exercise of the legislative power should become effective, because dependent upon future conditions, and it may leave the determination of such time to the decision of an executive, or, as often happens in matters of State legislation, it may be left to a popular vote of the residents of a district to be affected by the legislation.

"While in a sense one may say that such residents are exercising legislative power, it is not an exact statement, because the power has already been exercised legislatively by the body vested with that power under the Constitution, the condition of its legislation going into effect being made dependent by the legislature upon the expression of the voters of a certain district."

The Court also took the position that the statement in Congress clearly showed that the Tariff act was intended for revenue purposes, and on this second objection of the litigants Chief Justice Taft said:

"So long as the motive of Congress and the effect of its legislative action are to secure revenue for the benefit of general government, the existence of other motives in the selection of the subject of taxes cannot invalidate Congressional action.

"As we said in the child labor tax case, 'taxes are occasionally imposed in the discretion of the Legislature on proper subjects with the primary motive of obtaining revenue from them, and with the incidental motive of discouraging them by making their continuance onerous. They do not lose their character as taxes because of the incidental motive.'

"And so here the fact that Congress declares that one of its motives in fixing the rates of duty is so to fix them that they shall encourage the industries of this country in the competition with producers in other countries in the sale of goods in this country, cannot invalidate a revenue act so framed. Section 315 and its provisions are within the power of Congress."

Fall Meeting and Tour of A.I.C.E. in August

THE next general assembly of the Institute will be a joint meeting with the British Institution of Chemical Engineers and will comprise a tour of industrial centers of Eastern Canada and the United States. The Society of Chemical Industry, which is holding its annual meeting this year in New York during the week of September 3, will also participate.

The tour will begin at Quebec immediately after the arrival of our English

Itinerary of A.I.C.E. Tour

guests on August 18 and will end at New York, September 2. A three-day interim meeting will be held at Niagara Falls, August 24-26.

No mention is made in the itinerary of the various entertainment features that will naturally form a part of the visits to industrial centers. Members of the party will, however, be the guests of companies and individuals on a number of occasions. Ladies are cordially invited, and special provision will be made for their comfort and pleasure.

At Pittsburgh, while the men are inspecting the glass plant, the ladies will be specially entertained before returning to the city. Dinner will be served at the University Club, followed by an informal dance.

At Wilmington, Pierre S. du Pont will entertain the visitors at his beautiful country home in Longwood.

At Edgewood, Maryland, the Baltimore members of the American Institute of Chemical Engineers will tender an old-fashioned shore dinner.

Will Extract Helium in Amarillo District

THE final closing of a contract with the Amarillo Oil Company of Amarillo, Texas, which, it is thought, will greatly increase the available supply of helium, the rare non-inflammable gas required for the operation of dirigibles, is announced by the Bureau of Mines. Under the terms of the contract, the Bureau will undertake the extraction of the helium from natural gas from the company's leases on the Cliffside Structure in Potter County, Texas, at a new helium plant to be constructed by the government at Amarillo.

The Bureau of Mines, which has always played a prominent part in the development of helium for use in dirigibles, has had jurisdiction over production and conservation of helium for the War and Navy Departments since July 1, 1925. All of the helium produced by the government, to date, has been extracted from gas from the Petrolia field in Clay County, Texas, at the United States Helium Production Plant near Fort Worth, Texas. As this source of supply is no longer capable of meeting the demands of the War and Navy Departments, the Bureau of Mines has been working toward the development of other fields.

Harry B. Weiser to Lecture at Western Reserve

DR. HARRY B. WEISER, professor and head of the Department of Chemistry of Rice Institute, Houston, Texas, will give two courses of thirty lectures each in the field of colloid chemistry in the forthcoming summer session at Western Reserve University beginning June 18.

The first course, "The Colloid Chemistry of the Hydrous Oxides and Their Applications," will deal with the general theories of colloid chemistry with reference to the hydrous oxides. Special consideration will be given to the theories of gel structure and mechanism, with a discussion from the standpoint of colloid chemistry of such technical processes as tanning, mordant dyeing, the setting of cement, water purification, water softening by base exchange gels, etc.

Senate Committee Favors Leasing Soda Lands

The Senate Committee on Public Lands and Surveys, on March 30, ordered a favorable report to the Senate on the bill, which would amend the general leasing Act of 1920 with respect to disposal of sodium deposits discovered by permittees under that Act. Senator Oddie, of Nevada, is the author of the bill.

The Oddie bill would permit a permittee who discovers sodium to lease the entire area covered by his permit, instead of only one-half of it as under the present law.

NEWS FROM WASHINGTON

By Paul Wooton
Washington Correspondent of Chem. & Met.

INSECTICIDES valued at more than $6,000,000 were exported last year. In 1925 practically no insecticides were shipped abroad. Advices from abroad indicate that the demand for these American products bids fair to double and treble in the near future. This is being cited at the Department of Commerce as an example of what can be done where there is a will to export and where the effort is conducted in accordance with the best practice. One of the objectives of the annual conference of chemical executives has been to convince American manufacturers that it is easily possible to increase materially the percentage of their production going to foreign markets.

Two years ago the general assumption was that little demand existed abroad for household insecticides, particularly in the countries where living standards are low. Petroleum producers, however, who had developed an insecticide as a means of disposing of their surplus of kerosene, did not confine their sales efforts to the domestic market. To their surprise they found no better markets than in the countries where the great bulk of the population was supposed to be hard pressed to keep themselves supplied with the bare necessities of life. Apparently even these people were willing to deprive themselves of other things in order to have a certain freedom from the annoyance of insect pests.

An interesting feature of this trade is the fact that Japan is a large consumer of this product for which it sends to America the pyrethreum extract, the active ingredient.

If a world trade of these proportions can be developed for household insecticides it is contended that many other chemical products, not now exported, can be shipped abroad in material quantities, thus adding stability to the industry and increasing the volume of its sales and profits.

A LIST of papers to be read during the Adriatic voyage of the yacht Luetzow has been announced by the Nitrogen Syndicate of Germany. The purpose of the trip is to discuss means of stimulating the demand for nitrogen. The list referred to is as follows: "Economic Problems and Handling of Nitrogen," Dr. J. Bueb, Germany; "Some Nitrogen Problems," F. C. O. Speyer, Great Britain; "Cultivation of the Soil and Nitrogen Fertilizers," Professor L. Bretigniere, France; "The Natural and Economic Basis of the Application of Artificial Fertilizers," Prof. Dr. H. Warmbold, Germany; "Research and Education and their Relations to Practical Agriculture," Sir Frederick Keeble, Great Britain; "Results of the Concerted Action of Ammonia and Nitrate Fertilizers in Producing Higher Crop Yields," Dr. A. Demolon, France; "Relations Between Plant Growing and Increased Intensiveness of Agriculture," Prof. Dr. Erwin Baur, Germany; "Chemistry and Intensive Meadowland Cultivation," H. J. Page, Great Britain; "Fertilization in British East India and its Progress," T. J. Carroll, Great Britain; "Irrigation and Liming and their Relations to Nitrogenous Fertilizers," J. Galland, France.

As this is written, great uncertainty surrounds the prospects of Muscle Shoals legislation. The Military Affairs Committee of the House, after much wrangling, reported out a bill providing for the manufacture of fertilizer and the operation of the power plants by a government corporation. No public hearings were held on this proposal. While the measure is quite different than the Norris resolution which passed the Senate, there will be no trouble in harmonizing the two proposals in conference, as each of them is a government operation plan. The National Fertilizer Association has been particularly active in pointing out that the proposed amendment to the Norris resolution would be "unfair, discriminatory and destructive to the fertilizer industry" and also would create a precedent that "would constitute a threat against every American industry and against every security holder in the country." The Association charges that "trading of votes by the wholesale is taking place" with those who are anxious to see the passage of flood control, farm relief and the Boulder dam bill. Commenting further the Fertilizer Association says:

"A sub-committee of the Military Affairs Committee, apparently desperate to be rid of the problem, drafted this bill in three days. Then the whole committee quickly passed it, 17 to 4. No opportunity was allowed the fertilizer industry, which is vitally affected, to be heard relative to this bill, which is an entirely new proposal. This action was so hasty that some members of the committee who voted for it now understand the bill better and are understood to be secretly opposed to it."

OFFICIALS at the Department of Justice are outspoken in their determination of eliminating from the United States all manner of business operations on the part of foreigners which are not tolerated in business conducted by Americans. Active negotiations are under way with the potash interests and it is believed that satisfactory understanding will be reached. It is understood that the attitude of the German and French potash producers has been all that could be desired. Quite the contrary is the case, it is said, in the relationships with the Dutch Kina Bureau. The Dutch quinine interests are under indictment for conspiracy to restrain trade, to restrain competition, to increase prices and to monopolize the trade in that commodity. The rubber case has solved itself with the order under which restriction of production will be abandoned. The Department of Justice is understood to have under study practices in connection with the handling of asbestos, rayon, iodine and other commodities.

THE extent to which seaboard distillers of alcohol have made inroads on the business of the interior distillers is revealed in a decision of the Interstate Commerce Commission in which freight rates on denatured alcohol from New Orleans to points throughout the territory east of the Rocky Mountains, including Canadian points, were found unduly preferential to New Orleans and unduly prejudicial to Pekin, Ill. The decision points out that when distilling operations began at Pekin in 1892, corn was the principal raw material used for the production of alcohol. Pekin is in the corn belt, had the advantage of cheap coal and a good supply of water. It was near some of the largest consuming points and originally occupied a strategic location. Then it was found that blackstrap molasses is a particularly valuable source of alcohol. As the principal supply of that material comes from Cuba the distilleries located at New Orleans and along the North Atlantic Seaboard came into a distinct advantage. Blackstrap molasses came into greater and greater use until now it is the source of ninety per cent of the alcohol produced in this country, the decision points out, of which seventy-five per cent is at port cities. Half of this latter amount is produced in New Orleans. Figures compiled in the case show that shipments from Pekin in 1925 totalled 34,073,348 lb., whereas rail shipments from New Orleans totalled 194,860,256 lb. In addition, 6,866,186 lb. were shipped from New Orleans to eastern destinations by water. The American Distilling Company, the complainant in the case, pointed out that the rates from New Orleans were fixed sixteen to eighteen years ago when advantageous rates were necessary to offset the advantage of proximity to consuming points. It was contended that this disadvantage long since has been removed and that such low rates are not needed to enable New Orleans distillers to reach distant markets.

The long-fought case involving the validity of the flexible provisions of the existing Tariff act was settled on April 9 when the Supreme Court upheld all phases of the act.

Further Enlargement Reported for British Rayon Industry

New Plants Find Difficulty in Securing Necessary Equipment Without Serious Delays

From Our London Correspondent

THE RAYON industry is still in the limelight and almost every week one learns of plant extensions, new companies and favorable reports. The possibilities of viscose have at last been realized in Scotland, where the North British Artificial Silk Company has been formed with a capital of some one and a half million dollars. Another company of about the same size is the Yorkshire Artificial Silk Company, to which Sir William Pope is to act as chemical consultant. The Union Artificial Silk Company is installing a factory at Nottingham, jointly with Dutch interests, for making viscose silk. Messrs. J. & P. Coats, Ltd., have started production of an entirely new type of artificial silk thread and have had the advantage of the best advice and the co-operation of other important interests. Courtaulds have duplicated their large Wolverhampton factory, and, finally, there is announced the impending public issue of the shares of the British Acetate Silk Corporation with a capital of some ten million dollars. The latter company will take over the viscose and acetate silk plants at present being operated by the Bulmer Rayon Company at Stowmarket and their program is likely to be of particular interest, not only because their final production will be well over 25 tons per week of viscose and 50 tons per week of acetate silk, but because they have secured the services of Dr. Eichengrün of Berlin, who was one of the pioneers in the manufacture of cellulose acetate and the inventor of cellon and other products made from cellulose acetate. The co-operation of Dr. Eichengrün indicates that this company may not confine its activities to the production of yarn, but may launch out in new and unexpected directions. The Cellulose Acetate Silk Company, with which the Non-Inflammable Film Company is co-operating, has now entered, as anticipated, the splinterless glass field, through the formation of the Newtex Company. This type of splinterless glass involves the use of layers of cellulose acetate composition between the layers of thin polished plate glass.

The annual report of Courtaulds, Ltd., stated that although that company had experimented with the Lilienfeld processes and had exercised their option to use them jointly with the Nuera Company, it was not intended at present to proceed to the production stage with them. It is now understood that the purchase price was over $1,000,000 but it is not clear which of Lilienfeld's two main patents is being considered for future operation. The original patent dealt with the preparation of rayon by treating cellulose with alkyl sulphate or alkyl halide in the presence of an alkali, while the other covers improvements in the manufacture of viscose by using a temperature of between 0 and minus 25 degrees Centigrade.

ONE OF the difficulties confronting most of the new rayon companies is the difficulty of obtaining the necessary plants within schedule time; in fact manufacturers like Messrs. Dobson & Barlow can almost dictate terms and at the present time certain classes of machinery are definitely at a premium. Some of the continental manufacturers are taking advantage of this to introduce their wares, but except in certain categories British machinery is most in favor.

The British Metallizing Company has been formed to take over the business of Precious Metal Industries, Ltd.; the company's process consists of applying a metal coating or covering on non-metallic and base materials by the application of metallic or chemical salt to its surface, a firm adhesion being obtained. The salts when applied penetrate the surface and form a skin on the base material, which is then reduced to metal by an electrochemical process, and leaves a surface upon which any depositable metals, such as gold, silver, copper, etc., can be subsequently applied. In a way this method is similar to the normal process of homogeneous lead or tin coating, because the various deposits are firmly united and form a complete whole. The process has already been applied in many new directions in the industrial world and it enables goods so made to be hall-marked when gold or silver is used as the precious metal.

JUDGMENT has now been given in the hexyl resorcinol case previously referred to in these notes and on appeal the original judgment was upheld invalidating the patent of Messrs. Sharp & Dohme Incorporated, of U. S. A., who brought an action for infringement against Boots Pure Drug Company in this country. This case was of particular importance to chemists, inasmuch as if the judgment had gone the other way, publications by research workers might have been restricted unduly in the interest of the manufacturers concerned, seeing that otherwise it might be open to others to patent products obtainable by intelligent application of results foreshadowed by the research of others. Whether this case will now be taken to the highest tribunal, which in this country is the House of Lords, is doubtful, and according to those more qualified to speak on this subject than the writer, it seems hardly likely that the two decisions of the lower courts will be upset by a higher tribunal. About a year ago mention was made of the litigation between the Silica Gel Corporation of U. S. A., and the Medway Oil & Storage Company in connection with the purchase of a silica gel unit for purifying petroleum oil. Here the judgment in the court of first instance was in favor of the Medway Company, but on appeal, and again on March 9 in the House of Lords, this judgment was reversed and a decision given in favor of the Silica Gel Corporation. This case turned upon the question whether the buyers knew that the process had only so far been tried on a small scale, and that therefore the sellers' skill or judgment was not necessarily exclusive of the advice of the buyers' expert assistance. The buyers therefore openly took the risk and were held to have failed to use adequate caution in regard to the final application of the process to their plant.

Details have been published of the new power plant of Synthetic Ammonia & Nitrates, Ltd., at Billingham, of some 100,000 kw. The turbines are to operate at 630-lb. per square inch, with a super-heat to 833 deg. F. and exhausting at 275-lb. per sq.in. to the process part of the plant, and as far as need be to condensing turbines. Deaerators will be used for the condensed steam returned from the various portions of the works plant and in general the details of this installation will be of particular interest as representing the very large scale upon which Imperial Chemical Industries is planning future production and development. Favorable reports are reported by Nitram Limited in regard to the use of the new Billingham Fertilizer "Nitro Chalk." The results appear to be fully equal to the use of sulphate of ammonia, nitrate of soda or nitrate of lime, and two grades of nitro chalk are at present being marketed, containing varying amounts of nitrate of ammonia. The trials which are proceeding in regard to improved results with grass land are not yet complete, but the results are definitely encouraging.

Prof. G. T. Morgan, who is in charge of the research laboratory, at Teddington, run by the Department of Scientific and Industrial Research, has just contributed a paper on the study of high pressure syntheses, in which preliminary work on methanol and the like was outlined. While some of the results obtained are not without interest, it would seem that the present state of development at Teddington could have been obtained in a shorter time by taking advantage of existing knowledge, but it is an open question, whether for a governmental organization of this kind, it may not be preferable laboriously to purchase their experience themselves and so train up a team capable of higher development. The next two years will show whether the more traditionally British method will produce the desired result, but contrasted with the work which has been done in other countries and in the United States, the paper does not present much of interest or outstanding achievement.

French Rayon Production Controlled By Two Groups

Sixteen Factories Account for Nearly 85 Per Cent of Total Output

From Our Paris Correspondent

THE problem of synthetic petroleum production remains of prime interest, especially owing to the recent agreements made by the I.G. whose activity in this branch is well known. We should not at all be surprised to see the chemical industries of France and Germany—ex-minister Loucheur's recent speech on this subject is significant—take up the problem in hand.

German researches are made especially on lignite, Germany possessing very important lignite mines and being in a position to extract at a very low price. Carburants extracted from lignite can easily compete with the natural product.

France also possesses lignite deposits estimated at about a billion tons, according to competent experts. These mines are situated in South-Western and Southern France, thus are far from the northern and eastern frontiers where the majority of the coal mines are. A synthetic carburant industry could not live however without being supported by the state and helped by a custom tariff more liberal than the present one.

ACCORDING to statistics, France is the fourth largest rayon producing country in the world, the United States, Italy and Great Britain being respectively first, second and third. In France are two powerful groups: the Givet group and the Viscose group, producing together with their 16 factories about 80 to 85 per cent of the total French output. These two groups are closely united by their common sales bureau the "Comptoir des Textiles artificiels."

The Givet group owns the following works: La Soie artificielle, at Givet, output 2,500 to 3,000 kg. daily; La Soie d'Izieux, at Izieux, output 2,500 to 3,000 kg. daily; La Soie de Besançon, at Besançon, output 1,500 kg. daily; La Compagnie Nouvelle des Applications de la Cellulose, at Gauchy, output 2,000 kg. daily; Société Rhodiaseta, one-half of which belongs to the Usines du Rhône, at Péage-du-Roussillon, 7,000 kg. daily; and at Lyon-Vaise under construction for a daily output of 3,000 kg. La Cuprotextile, one-half of which belongs to the Bemberg group, at Roanne, output 700 kg. daily; La Soie de Saint-Chamond, at St. Chamond, 1,000 to 1,200 kg. daily; La Soie artificielle du Sud-Est, at Vaulx-en-Velin, 5,000 kg. daily; and at Voulte-sur-Rhône, 1,200 kg. daily.

The Viscose group is made by the following firms: La Viscose Française, at Arques-la-Bataille, 3,500 kg. daily; Société Ardèchoise de la Viscose, at Vals, 1,500 kg. daily; Société Italienne de la Viscose (the works of Venaria Reale of this society are now owned by the Snia Viscosa), at Albi, 1,500 kg. daily; Société des Crins artificiels, at Saint-Just-des-Marais, daily output—rayon 1,000 kg. and artificial horsehair 500 kg.; Société Nouvelle de la Soie Artificielle, at Saint-Aubin-des-Elbeuf.

The united groups have formed two new firms: Société Nationale de la Viscose, at Grenoble; daily output: 8,000 kg.; and Soie Artificielle d'Alsace, at Colmar, daily output 5,000 kg.

All these firms except Rhodiaseta and Cuprotextile, use the viscose rayon process. Rhodiaseta produces a very fine acetate rayon and Cuprotextile will shortly manufacture a copper rayon by the new Bemberg process. The total output of these various firms could roughly amount to 40,000 kg. but real production is about 33,000 kg.

Other rayon works of importance are the following: Société Lyonnaise de Soie Artificielle, at Décines, daily output: 3,500 kg. These works are affiliated with the Dutch Enka and to Chatillon. Soie de Compiègne, at Aubenton and Clairoix; actual total output 3,000 kg.; Soie de Valence, at Valence and at Avignon, total output: 3,500 to 4,000 kg. The Comptoir des Textiles controls indirectly these works; Soie de Strasbourg, at Strasbourg, daily output: 1,500 kg. Courtauld's and Tubize are shareholders of this firm. Soie de Feyzin, at Feyzin, daily output 1,000 kg. The Coptoir des Textiles indirectly controls this firm; Soie de Valenciennes, branch establishment of the Breda, at Valenciennes, daily output: about 1,200 to 1,500 kg.; Soie Vauban, at Condé and at Beauvais, total output of both works: 2,000 kg.; Soie d'Argenteuil, at Argenteuil, output: 700 kg.; Soie de Saint-Etienne, at Neuveille, output: 350 kg.; Tubize Française, at Grand-Quévilly and Vénissieux, total output: 4,000 kg.; present daily output: 2,500 kg.; Soie de Calais, branch establishment of Courtauld's which will shortly produce about 5,000 kg. daily.

Several rayon works of less importance are not included in this figure —Rennes, Borvisk of Nevers, Montescourt, Verdun, Amiens, Guise, Rhétel, etc.

Canners Seek To Replace Wooden Brine Tanks

DR. W. D. BIGELOW, director of the Research Laboratory of the American Canners Association announces that more attention is being given to the replacement of wooden brine tanks with tanks made of some hard-surface material. In this connection he believes that it may be advisable if stainless steel tanks of the welded side seam type were available with a capacity from 200 to 500 gallons.

An important requirement, however, he points out, would be that these tanks should be available at a reasonable price. The brine solution commonly used is from five to fifteen per cent sugar and two per cent salt. Dr. Bigelow also expressed interest in the matter of piping of stainless steel of from one to two inch diameter.

Higher Duty for Precipitated Barium Carbonate

UNDER the provisions of section 315 of the tariff act of 1922, the President has proclaimed an increase in the duty on precipitated barium carbonate from 1 cent to 1½ cents per pound.

To assist the President in determining the differences in costs of production, the Tariff Commission made an investigation of the cost of production of precipitated barium carbonate in the United States and in Germany, the principal competing country. A public hearing was held in the offices of the commission in Washington at which interested parties were given an opportunity to appear and produce evidence.

Precipitated barium carbonate is a white insoluble chemical compound made in West Virginia and Illinois. Barytes ore, the mineral from which it is made, is mined in the United States chiefly in Missouri, Georgia, and Tennessee, and in Germany in the Hartz Mountains, chiefly in Thuringia and Westphalia. The finished manufactured chemical is dutiable under paragraph 12 of the act of 1922 and should not be confused with the natural mineral barium carbonate, witherite, which is specifically mentioned in the free list.

In the order of importance, the uses of precipitated barium carbonate are: (1) in the manufacture of face brick, terra cotta, roofing tile, and sewer pipe to prevent the development of a white scum which would otherwise result from the leaching of the soluble salts; (2) as a fusing agent in making enamel ware, plumbing, and electrical fixtures; and (3) in the manufacture of barium peroxide and other barium chemicals, in case hardening compounds and in the purification of water.

The domestic consumption of precipitated barium carbonate from 1924 to 1926, inclusive, ranged from about 8,200 to 14,600 tons per year. Imports increased from nearly 2,000 tons in 1923 to over 9,000 tons in 1926, but declined to 5,000 tons in 1927. Production ranged from about 5,000 to slightly more than 6,000 tons per year during this period.

The change in the rate of duty of 1c. to 1½c. per lb. is based upon the difference in cost of production in the United States and in Germany. The cost of production in Germany, including transportation to New York, was 1.5565c. per lb., and the cost of production in the United States, delivered at New York, was 3.5825c. per lb., or a difference of 2.0260c. per lb.

News in Brief

LAST YEAR is interesting with regard to the production and consumption of oil in Germany, as it is the first year in which oil produced from coal has appeared upon the German market in commercial quantities, states consul Hamilton C. Claiborne. Toward the close of 1927 the I. G. Farbenindustrie A. G. of Frankfort was producing synthetic gasoline at the rate of 1,200 tons per month, with a program calling for production during 1928 at a rate of 10,000 tons monthly.

TWENTY-THREE YEARS after the inauguration of the first courses in engineering at the University of Southern California a college of engineering has been created at that institution. The demand for engineering education in this section of the southwest on the part of the young men of this region and the need of industries in southern California for centralized and adequately-equipped engineering laboratories has led the board of trustees of the University to authorize this college. Philip S. Biegler, professor of electrical engineering at the University for the past five years, has been appointed acting dean.

THE ANNUAL MEETING of the American Institute of Chemists will be held at Washington, D. C., on May 12. The Mayflower will be the official headquarters for the Institute and the business meeting in the afternoon, the annual dinner and the program for the evening will be held there. In order that the Institute can function with greater ease, the constitution and by-laws have been completely revised by a committee appointed by the president Prof. Treat B. Johnson. This revised constitution has been approved by the council and is now being submitted to the members. These changes will be discussed at the annual meeting, following which they will be submitted to the entire voting membership of the Institute for a mail vote.

THE SECOND ANNUAL Production Conference of the Carbonization, Chemical, and Water Gas Committees of the American Gas Association will be held at Rochester, N. Y., at the Hotel Seneca, on May 22, 23 and 24. H. H. Himsworth, chairman of the Joint Program Committee, states that the committee in charge has developed a program providing material for real and interesting discussion. Half day sessions are allotted as follows: Tuesday, May 22, Morning Session—Carbonization; Tuesday, May 22, Afternoon Session—Water Gas; Wednesday, May 23, Morning Session—Chemical; Wednesday, May 23, Afternoon Session—Carbonization; Thursday, May 24, Morning Session—Water Gas; Thursday, May 24, Afternoon Session—Chemical.

A COURSE in colloid chemistry, will be given this summer at the Massachusetts Institute of Technology by Dr. Ernst A. Hauser of Germany. The program is of special interest in two respects. In the first place, while the work is advanced in character and presupposes a mastery of general chemistry, it will start with the underlying fundamentals of colloid chemistry itself. In the second place, the program includes a considerable proportion of laboratory work. Furthermore, provision is made to allow the student, after such introductory laboratory work as may be necessary, to specialize on experimental problems in which he is personally most interested.

A NUMBER of additional tariff changes have been passed by the Canadian House of Commons, according to reports to the Department of Commerce. Formaldehyde containing not more than 15 per cent of alcohol is admitted free of duty from all countries. Crude petroleum not in its natural state .725 specific gravity or heavier but not heavier than .770 specific gravity at 60 degrees temperature, when imported by oil refiners to be refined in their own factories, will be admitted free of duty from all countries, until July 1, 1931.

IT WAS REPORTED some time ago that successful tests had been made on a commercial scale with the "Classen process" for using sawdust, straw, bagasse and sisal waste as raw materials for the production of glucose and ethyl alcohol. It appears that the process consists in saturating the materials with hydrochloric acid gas in the presence of catalyzers, thus converting the cellulose into glucose from which the acid is removed by subsequent treatment. The product can be sold as cattle food and when refined, to pure glucose may be sold for human consumption, or can be fermented to industrial alcohol. When dried sawdust has been used as a raw material, it is reported that as much as 60 per cent of its weight has been obtained as glucose.

Lectures Arranged for Chemical Exposition in 1929

The management of the Twelfth Exposition of Chemical Industries which will be held in the Grand Central Palace, New York, during the week of May 6, 1929, announce that they are arranging for a series of lectures upon chemical engineering, apparatus, instruments and chemical products applied in the arts. These lectures will be prepared by members of the staffs of exhibitors in the exposition and will be available for presentation in educational institutions throughout the country.

This course of lectures will in some measure be an extension of the Students Course which is a regular feature of each Exposition and will now for the first time become available to colleges and technical schools which desire to avail themselves of an opportunity to have their advanced students hear discussions by authorities upon the various subjects.

Franco-German Dye Agreement Is Enlarged

IN A report from Frankfort on the Main, Consul H. C. Claiborne stated that the Franco-German agreement relating to dyestuffs is being extended to cover nitrogenous products and mixed fertilizers. The Kuhlman interests already have financial participations in the Norsk Hydro and come into contact with the I.G. through the latter's agreement with that concern, while the manufacture of mixed fertilizers is being undertaken in France following the I. G.'s production of nitrophoska and the British Chemical Combine's nitrochalk, movements which constitute ample evidence of confidence in the success of such mixed fertilizers.

Competition in production and sales of dyestuffs is abandoned and uniformity in dyestuffs organization in France and Germany is to be aimed at. Although each country is to maintain independence in an economic sense production and sales will be apportioned as to quantities and varieties on a basis of industrial and commercial economy. Dye production, both present and future, will leave the ratios between the two countries intact which, of course, gives ample latitude for increase of production, if warranted by sales.

No little publicity was given to the declarations of the participants that the objects of the agreement were to rationalize production in order to reduce prices and increase consumption, although it may be remarked that the effect of such agreements are, as a general rule ultimately to increase prices. Emphasis was also placed upon statements that the agreement was in no sense directed against other countries and visualized the possibility of its extension to other countries, although those countries not participating in the agreement may expect intensified competition in foreign markets and it is worthy of comment that responsible sources are in agreement that deficiencies in production or types of dyes in one participating country will be drawn from the other or others. Of interest also are the recent unconfirmed statements in the press that the I.G.'s sales organization will take over the sale and distribution of French dyestuffs in the Far East and that the French selling organization will handle the I.G.'s dyestuffs in Spain and unspecified other countries, arrangements which are expected to result in substantial economies and to be followed by similar sales agreements for other fields. France will take up the manufacture of a number of dyes which it has not hitherto produced, receiving German technical aid and largely covering her remaining requirements in Germany.

It may also be recalled that at the time of the failure of Anglo-German negotiations for a dyes agreement and the announcement that such negotiations had been indefinitely postponed the I.G. issued a statement to the effect that it had been impossible to reach a "purely commercial agreement" with the British.

MEN *in Chemical Engineering*

HARRY A. CURTIS, professor of chemical engineering at Yale University, will attend the International Nitrogen Conference in the Adriatic on board the *Lützow* as a representative of the United States Department of Agriculture. Professor Curtis sailed from New York on April 11, the conference beginning on April 30.

BRUCE K. BROWN has become associated with Fish, Richardson & Neave and will enter the practice of patent law in New York about May 1st. For the past four years he has been director of the patent and research information departments of the Commercial Solvents Corporation, and prior to that time he was engaged in chemical engineering work with the Burgess Laboratories.

E. G. JARVIS, president of the Niagara Falls Smelting & Refining Corporation, has been elected chairman of the Metal division of the National Association of Waste Material Dealers, Inc. Mr. Jarvis is also president of the American Boron Products Company and chairman of the board of the Ladle Ring Corporation of America.

JAMES D. TEW, first vice-president and general sales manager of the B. F. Goodrich Rubber Company, has been elected president of that organization to succeed Harry Hough who recently resigned. Mr. Tew has been with the company since 1906, having joined it soon after receiving the degree of B.S. in Mining at Harvard University. In 1918 he was placed in charge of the entire tire division, and thereafter his rise had been steady, covering successive executive posts.

L. H. ADAMS, of the geophysical laboratory of the Carnegie Institute, has been appointed secretary of the central petroleum committee of the National Research Council. This body acts as advisor to the American Petroleum Institute in expending the funds for fundamental research donated by John D. Rockefeller and the Universal Oil Products Company.

D. LEON BATCHELDER, who has been active in the nitrocellulose industry for the past five years, has recently joined the staff of the Bureau of Employment of the Chemists' Club. His post is that of field secretary, in which the service to employers and applicants is to be furthered by means of personal contact, especially in the metropolitan district.

EDGAR S. ROSS is now manager of research and development for the Headley Good Roads Company, Philadelphia.

JOHN V. FREEMAN has been appointed chairman of the chemists' committee of the U. S. Steel Corporation, succeeding the late J. M. Camp. Mr. Freeman, whose offices are to remain at 71 Broadway, New York City, will continue as technical assistant to the president of the corporation. Charles B. Francis continues as secretary of the chemists' committee and also becomes director of the

JOHN V. FREEMAN

Bureau of Instruction of the Carnegie Steel Company at Pittsburgh. Mr. Freeman has been with the Steel Corporation for the past twenty years, of which seventeen were spent in operations at the various plants.

ROBERT WEATHERLY, who has been assistant sales manager of the Federal Phosphorus Company for several years, has now been promoted to the post of sales manager for the associated Federal companies.

EDWARD E. MARBAKER is the holder of the new industrial fellowship established at the Mellon Institute, Pittsburgh, by the Whiting Corporation, Harvey, Ill. Dr. Marbaker has been chief chemist for the Westinghouse Lamp Company and the Cleveland Lamp Works of the General Electric Company and will conduct research on cast iron in his new capacity.

PROF. A. I. KENDALL has left the Medical School of Washington University to become Research Professor of Bacteriology at Northwestern University.

HARRY N. HOLMES of Oberlin College will give two series of lectures at the American Chemical Society Institute, which meets at Evanston, Ill., from July 23 to August 18.

H. E. HARING, who has been engaged in electrochemical research at the National Bureau of Standards for the past nine years, is now on the staff of the Victor Talking Machine Company, Camden, N. J.

S. W. BULL, of the development department of the Door Company, sailed for Europe on the *Leviathan* on March 24, in connection with special beet sugar work on the continent.

LEWIS BUCKLEY STILLWELL of New York has been re-elected chairman of the Engineering Foundation, and now enters his fourth term in that capacity.

ARTHUR D. LITTLE, president and founder of Arthur D. Little, Inc., Cambridge, has been re-elected vice-chairman of the Engineering Foundation, the research organization of the national engineering societies.

WILLIAM MCCAUGHEY of Ohio State University addressed the Pittsburgh Section of the American Ceramic Society at the Mellon Institute on April 10, speaking on "The use of petrographs and X-rays in ceramics."

WILLIS APPLEFORD SLATER, engineer physicist in the Bureau of Standards, Washington, D. C., and chief of the section on Masonry Construction, has been elected research professor of Engineering Materials and director of the Fritz Engineering Laboratory in the department of Civil Engineering at Lehigh University.

H. E. BARNARD, who has resigned the presidency of the American Institute of Baking, has organized the firm of H. E. Barnard, Inc., at Indianapolis. Dr. Barnard will be a consultant on the various technical and economic problems of the food industries.

MACDONALD C. BOOZE, vice-president of the Charles Taylor Sons Company, Cincinnati, is the newly elected president of the American Ceramic Society. After graduating from Illinois in 1915 he was a plant superintendent for the Medal Brick Paving Company and in 1919 took charge of the ceramic research department of the Norton Company, Worcester, Mass. Before assuming his present post, Mr. Booze was a senior fellow on refractories at the Mellon Institute for three years.

R. M. BURNS, of the Bell Telephone Laboratories, has been appointed representative of the American Electrochemical Society on the National Research Council, in the Division of Chemistry and Chemical Technology. He suceeds H. C. Parmelee, whose term will expire on July 1.

HELMUT W. GEYER, a recent graduate in fuel and gas engineering at the Massachusetts Institute of Technology, has joined the Philadelphia Gas Works Company in the capacity of industrial fuel engineer.

OBITUARY

THEODORE WILLIAM RICHARDS, the professor of chemistry at Harvard University, and holder of numerous international distinctions for his scientific achievements, died at his home in Cambridge on April 2 after several weeks' illness.

Professor Richards, who was born at Germantown, Pa., in 1868, received his B.S. degree at Haverford in 1885 and then attended Harvard, where he attained the degrees of A.B. and Ph.D. After spending several further years of study in Germany, he returned to Harvard to resume the connection that was to last until his death. There he became professor of chemistry in 1901, and assumed the guidance of the department in 1903.

Although physical chemistry formed the general field of Professor Richards' activities, it was by his work on atomic structure that he gained international fame. He directed the revision of a large number of atomic weights and in 1908 served on the International Committee on Elements and Atomic Weights. The bestowal upon him of the Nobel prize for 1914 was only one of many signs of recognition accorded him by universities and scientific bodies in Europe and America.

CHARLES H. VIOL, secretary of the Standard Chemical Company, Pittsburgh, and director of the Radium Research Laboratory of that company, died on April 6, of cancer, a victim of his sixteen years' experimental work with radium and radon. Dr. Viol was born in 1886 at Lafayette, Ind. He attended Purdue University until 1907 and upon graduation became instructor for two years at South Dakota State College. In the further course of his career he became a leading contributor to radiochemistry and radon technology.

THOMAS BRUCE FREAS

THOMAS BRUCE FREAS, professor of chemistry at Columbia University and well known inventor of industrial chemical apparatus and authority on chemical thermodynamics, died on March 15 after a short illness following an operation.

Professor Freas was 59 years of age, having been born in Newark, Ohio, in 1868. After receiving his A.B. at Leland Stanford in 1896 he became for a time principal of a Kansas high school and then chemist for the Western Electric Company in Chicago before forming a long connection with the University of Chicago. He remained there for twelve years, serving from 1904 to 1911 in the capacity of instructor, and receiving his Ph.D. degree in 1911. Thereafter he came to Columbia as assistant professor, and was later promoted to professorship.

Besides his contributions in the field of chemical apparatus, Professor Freas designed the laboratory features of the new Chandler building at Columbia. In addition he headed the Freas Thermo-Electric Company, of Irvington, N. J., in the capacity of president.

C. L. PARKER, who has practiced patent and trade-mark law in Washington, since 1903, died in that city on March 19. Mr. Parker received his B.S. and M.S. degrees at George Washington University and after the completion of his law studies, specialized in chemical patents and inventions.

CALENDAR

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, convention, New York City. Dec. 27, 1928-Jan. 2, 1929.

AMERICAN CERAMIC SOCIETY, tour through France, Germany, Czecho-Slovakia and England, May 19-July 16.

AMERICAN ELECTROCHEMICAL SOCIETY spring meeting, Bridgeport, Conn., April 26-28.

AMERICAN GAS ASSOCIATION, Natural Gas Department, annual meeting and exhibition, Dallas, Texas, May 7-10.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, tour, with British Institution of Chemical Engineers, Quebec, Shawinigan Falls, Montreal, Ottawa, Kirtland Lake, Port Colborne, Niagara Falls, Akron, Pittsburgh, Wilmington, Edgewood, Washington, and New York, August 18-Sept. 2.

AMERICAN INSTITUTE OF CHEMISTS, annual meeting, Washington, D. C., May 12.

AMERICAN OIL CHEMISTS' SOCIETY, annual meeting, New Orleans, May 14, 15.

AMERICAN REFRACTORIES INSTITUTE, annual meeting, White Sulphur Springs, W. Va., May 8, 9.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting, Pittsburgh, May 14-17; regional meetings, St. Paul-Minneapolis, Aug. 27-29, Boston, Oct. 1-3. Fuels Division, second national meeting, Cleveland, Sept. 17-20.

AMERICAN WELDING SOCIETY, annual meeting, New York City, April 25-27.

INSTITUTE OF CHEMISTRY OF THE AMERICAN CHEMICAL SOCIETY, second session, Evanston, Ill., July 23-August 18.

NATIONAL COLLOID SYMPOSIUM, sixth symposium, University of Toronto, Toronto, Canada, June 14-16.

NATIONAL FOREIGN TRADE COUNCIL, 15th convention, Houston, Texas, April 25-27.

NATIONAL LIME ASSOCIATION, 1928 convention, New York City, May 23, 24.

INDUSTRIAL NOTES

THE CUTTER ELECTRICAL AND MANUFACTURING COMPANY, Philadelphia, has determined to assume the new name, the I—T—E Circuit Breaker Company, in view of possible confusion with other manufacturers.

THE NIAGARA FALLS SMELTING AND REFINING CORPORATION has appointed George B. Michie, Western representative with headquarters at Chicago.

THE PRESSED STEEL TANK COMPANY has made R. P. Diekelman vice-president and Herman Merker secretary and sales manager.

THE CHEMICAL EQUIPMENT MANUFACTURING COMPANY, of Paterson, N. J., has placed Adolph Friedberg in charge of a new agency at 320 Lagaucheterie St., W., Montreal, Canada.

COMBUSTIONEER, INC., is the name of a new company organized by former officials of the Iron Fireman Corporation of Chicago. It is located at 510 West Randolph St., Chicago, and manufactures automatic coal burners.

THE L. B. FORTNER COMPANY announces the removal of its Boston office to 85 Broad Street.

THE AMERICAN BOSCH MAGNETO CORPORATION merged its Detroit branch with the Chicago branch on March 15. C. L. Shedd has been made manager of general sales.

THE AMERICAN PULVERIZER COMPANY, manufacturer of American Rolling Ring crushers, has moved into a new plant at 1249-53 Macklind Ave., St. Louis, with facilities for twice the former production capacity.

THE WORTHINGTON PUMP & MACHINERY CORPORATION has moved its executive offices and export and New York district sales departments to 2 Park Avenue, New York City. The head office sales and advertising departments are now located at the Harrison, N. J. plant.

THE CARBIC MANUFACTURING COMPANY, Duluth, Minn., will henceforth have its acetylene products distributed by the Oxweld Acetylene Company, New York City, and its processed carbide, under the name of Carbic, by the Union Carbide Sales Company, New York.

THE SPRAY ENGINEERING COMPANY, INC., has opened a branch office at 15 Park Place, New York City, in charge of C. T. Keet.

THE FOOTE BROS. GEAR & MACHINE COMPANY of Chicago has appointed Bentley & Holmgren, Bridgeport, Conn., representatives for Connecticut and western Massachusetts.

THE STEPHENS-ADAMSON MANUFACTURING COMPANY, Aurora, Ill., has opened branch sales engineering offices at Toronto and Montreal, Canada, following the establishment of a complete manufacturing plant at Belleville, Ontario.

THE BROWN INSTRUMENT COMPANY has obtained larger quarters for its Detroit branch at 576 Maccabee Building, with R. W. Mayer in charge.

THE D. O. JAMES MANUFACTURING COMPANY, Chicago, has appointed R. C. Bird traveling sales manager.

THE NATIONAL FLUE CLEANER COMPANY, Groverville, N. J., has appointed the Naylor-Hickey Corporation, 643 Washington Boulevard, as Chicago representative, and the Furnace Improvement Company, 511 Westminster St., Providence, R. I., as representative for New England.

THE STUEBING COWAN COMPANY of Cincinnati, Ohio, will henceforth have its products distributed in New York by the Leeds, Tozzer & Company, 75 West St.

THE CONSOLIDATED PRODUCTS COMPANY, specializing in used chemical machinery, has moved into enlarged quarters at 15 Park Row, New York City.

THE C. O. BARTLETT & SNOW COMPANY of Cleveland has appointed W. H. Narrington as representative for New York City, with his office at 30 Church St.

THE FOOTE BROS. GEAR & MACHINE COMPANY, Chicago, will now be represented in the Oklahoma district by the Mideke Supply Company, Oklahoma City.

THE AMERICAN RADIATOR COMPANY is moving the headquarters of the accessories division from Chicago to 40 West 40th St., New York City.

THE CELLULOSE PRODUCTS, INC., of Boston, has announced the change of its name and address to the American Powder Company, general office, Maynard, Mass., and sales office, 131 State St., Boston.

THE KANSAS CITY OXYGEN GAS COMPANY announces the opening of a new plant at Baltimore, Md., to serve the Atlantic seaboard trade.

THE BUFFALO FOUNDRY & MACHINE COMPANY has acquired the complete assets of the Chemical & Vacuum Machinery Company.

MARKET CONDITIONS *and* PRICE TRENDS

Census Returns Indicate Growth in Domestic Dye Trade

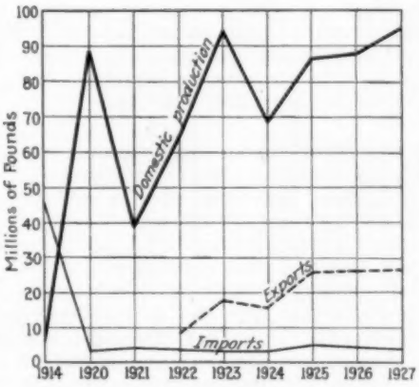
Home Output of Coal-Tar Dyes Established Record Last Year

PRELIMINARY figures complied by the United States Tariff Commission show that the domestic production of coal-tar dyes for the calendar year 1927 exceeds the production of any previous year in the history of the American dye industry. Prior to the war the United States was largely dependent upon foreign sources for its supply of dyes. Synthetic colors are essential for the large domestic textile and other dye-consuming industries. In 1927, dyes of domestic production supplied 94 per cent of our consumption, and there was, in addition, an exportable surplus of the bulk low-cost colors amounting to over 26,000,000 lb.

The 1927 production of approximately 95,000,000 lb. was an increase of 8 per cent over the production of 1926. The sales of dyes in 1927 were about 98,200,000 lb., valued at $38,200,000. The increase in sales over 1926 amounts to 13.8 per cent by quantity, and 5.2 per cent by value. Other outstanding features of American dye production during the year 1927 were: Continued price recessions, increase in production of vat and other fast dyes, production of many new fast and specialty dyes, reduction in the number of domestic manufacturers, decrease in dye imports, and increase in the quantity and decrease in value of exports.

The production of vat dyes in 1927 set a new record with a total of over 4,500,000 lb., as compared with 4,000,000 lb. in 1926. Before the World War there was no production of vat dyes in the United States and our entire consumption was imported from Germany and Switzerland. These dyes are of the greatest interest to the consumer of fabrics, as they yield shades of exceptional fastness to washing and light, and are largely used on cotton and linen goods.

Many domestic textile manufacturers have in recent years placed on the market a variety of fast-dyed fabrics of cotton and linen marked with a trade name and bearing a statement or guarantee as to their fastness. These fabrics are frequently made up into garments, such as dresses, men's shirts, and children's clothing similarly guaranteed. The public at large is thus coming to the realization that although the fast dye is more expensive, the cost of dye per yard of fabric or per garment is, in general, a small fraction of the total cost, and that it is more economical in the long run to invest in the fast-dyed fabrics or garment. The increased consumption of vat dyes is proof of the demand for them.



Domestic Production and Foreign Trade in Dyes

A summary of the production and sales of dyes and other finished coal-tar products for the year 1927 is shown in Table I. The total production of these products exceeds the production of any year since 1918. In this summary photographic chemicals are not included as complete returns regarding production had not been received from the different manufacturers.

Table I—Dyes and Other Finished Coal-Tar Products: Domestic Consumption and Sales, 1927

Name of Product	Sales Quantity Lb.	Production Quantity Lb.
Finished products:		
Dyes	98,200,000	95,000,000
Color lakes	11,100,000	11,200,000
Medicinals (a)	3,600,000	3,700,000
Flavors	1,800,000	1,800,000
Perfumes	2,000,000	2,000,000
Synthetic tanning materials and Synthetic phenolic resins	16,800,000	17,100,000
Total	133,500,000	130,800,000

(a) Partly estimated; returns incomplete.

Table II—Coal-Tar Dyes: Domestic Production and Sales, 1914, 1920-1927

Year	Production Quantity Lb.	Sales Quantity Lb.
1914	6,619,729	.....
1920	88,263,776	.....
1921	39,008,690	47,513,762
1922	64,632,187	69,107,105
1923	93,667,524	86,567,446
1924	68,679,000	64,961,433
1925	86,345,438	79,303,451
1926	87,978,624	86,255,836
1927	95,000,000	98,200,000

More Surphuric Acid Used in Fertilizers

THE Department of Commerce announces that, according to data collected at its recent semi-annual canvass, fertilizer manufacturers during the second half of 1927 produced 877,792 tons of sulphuric acid and consumed 1,043,833 tons in the manufacture of 1,003,000 tons of superphosphates containing 32,301,000 units, of 20 lb. of available phosphoric acid. The production of sulphuric acid by fertilizer manufacturers was thus equal to 84.1 per cent of their total consumption. Superphosphates sold as such amounted to 703,013 tons, containing 11,896,000 units of available phosphoric acid; and 337,238 tons of superphosphates containing 6,034,000 units, were consumed in the manufacture of other products classed as fertilizers.

The statistics for the second half of 1927 as compared with those for the second half of 1926 show increases of 5.4 per cent in production of superphosphates, and 7.3 per cent in total sales of superphosphates, an increase of four-hundredths of 1 per cent in stocks of sulphuric acid on hand at the end of the period, and a decrease of 4.3 per cent in stocks of superphosphates.

The statistics for the second half of 1927 are based on the reports of 173 establishments, of which 115 are located in the Southern District, distributed by States as follows: Alabama, 18; Arkansas, 1; Florida, 6; Georgia, 35; Louisiana, 4; Mississippi, 6; North Carolina, 18; South Carolina, 19; Tennessee, 7; Texas, 1. The remaining 58 establishments are located in the Northern and Western Districts, distributed by States as follows: California, 2; Illinois, 4; Indiana, 5; Kentucky, 1; Maryland, 8; Massachusetts, 2; Michigan, 1; Montana, 1; New Jersey, 4; New York, 1; Ohio, 16; Pennsylvania, 4; Virginia, 9. The manufacture of sulphuric acid was reported by 63 establishments in the Southern District and 25 in the Northern and Western Districts.

ECONOMIC INFLUENCES *on production and consumption of* CHEMICALS

Gain Reported in Volume of Chemical Production Last Month

Increased Call From Consuming Industries Encouraged Greater Activity Among Producers

VERY substantial increases in demand for chemicals were reported for last month. With few exceptions, consuming industries were more active than was the case earlier in the year. Evidence of this is found in the fact that employment in manufacturing industries was 0.7 per cent greater in March than in February and the payroll totals were 1.3 per cent larger, according to a report made by the Bureau of Labor Statistics. The trend of employment in March has been upward in five of the last six years, but the increase in 1928 is greater than in either 1927 or 1926. With these increases the volume of employment in March, 1928, stood at a higher level than at any time since October, 1927, while payroll totals were greater than any time since June, 1927, with the single exception of October, when they were at the same level as in March.

The Bureau of Labor Statistics' weighted index of employment for March, 1928, is 86.1, as compared with 85.5 for February and 91.4 for March, 1927; the weighted index of payroll totals for March, 1928, is 91.2, as compared with 90 for February, 1928, and 92.7 for March, 1927.

THIRTY-FOUR of the fifty-four separate industries had more employees in March than in February and thirty-six industries reported increased payroll totals, the majority of the increases being of a seasonal character. Fertilizer employees had increased 39 per cent, while employees in the following industries had increased from 3.1 per cent to 4.9 per cent each: agricultural implements, cast-iron pipe, stamped ware, automobiles, ice cream, glass, and brick. Nearly all of these industries reported corresponding increases in payroll totals, and the following industries, with smaller increases in employment, also reported substantially increased payroll totals: sugar refining, foundries and machine shops, machine tools and sawmills. The iron and steel industries had gained about 2 per cent each in employment and payroll totals.

The notable decreases in March were in woolen goods, book and job printing, chewing tobacco, rubber boot and shipbuilding industries.

The chemical group as a whole shows the greatest gains in March, due to the striking increases in the fertilizer industry; the stone-clay-glass group's large increases were due to seasonal prospects in building construction, as were the gains in the iron and steel and lumber groups. The vehicle group owed its advance largely to the activity in automobile factories.

REPORTS from manufacturers of chemicals also are of an encouraging nature. Deliveries of soda ash and caustic soda in March were reported to have exceeded those for March, last year, and the total movement for the first quarter of the year is practically equal to that for the corresponding period of 1927. That statement will hold good for chemicals in general as the larger distribution in March made up for the deficiency in the two preceding months and brought the totals for the first quarters of 1927 and 1928 about on an equal footing.

The fertilizer season to date shows up very favorably with sales of fertilizer tags in the cotton-growing states, placed at 3,776,358 tons from August, 1927, to March, 1928, inclusive, as compared with 2,687,070 tons for the corresponding period of the preceding season. Statistics covering automobile production indicate a gain of 40 per cent in output for the first quarter of 1928 over the first quarter of 1927. Demand for window and plate glass has been larger so far this year.

On the other hand the cotton goods trade has gone along slowly and consumption of chemicals for dyeing and finishing textiles has not come up to expectations. This condition shows no signs of righting itself and wage reductions in textile centers in New England have resulted in labor troubles which may further complicate the situation.

Building operations so far this year have been on a large scale and this has favored an extensive use of paints which has been reflected in a steady call for chemicals, solvents, etc., from that industry. Soap makers also have been operating actively with a corresponding demand for chemicals.

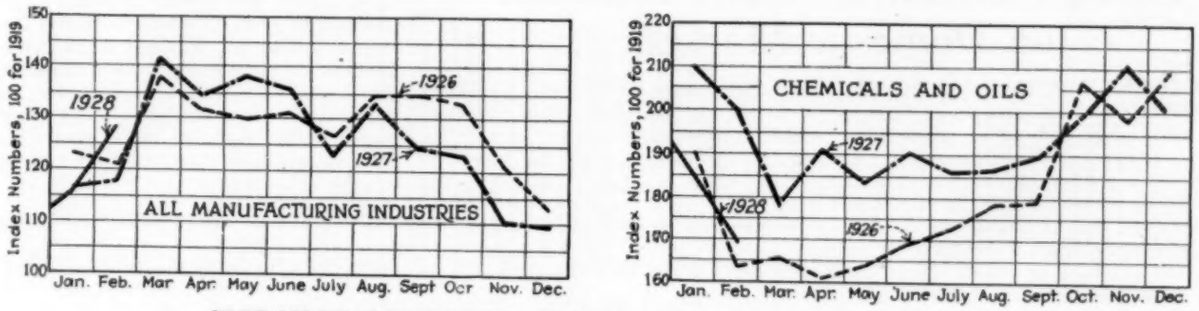
The Fertilizer Industry—Production, Consumption, Sales, and Stocks of Sulphuric Acid: 6-Month Periods, July 1, 1926, to December 31, 1927

United States	1927 2nd Half July-Dec., Tons	1927 1st Half Jan.-June, Tons	1926 2nd Half July-Dec., Tons
Stocks on hand at beginning of period	85,708	97,043	86,247
Produced in establishments reporting	877,792	779,079	810,326
Purchased*	366,504	266,911	413,836
Total	1,330,004	1,143,033	1,310,409
Consumed in making fertilizers	1,043,833	853,888	972,806
Sales:			
To fertilizer works	122,207	117,201	155,079
To other than fertilizer works	70,793	82,217	89,393
Stocks on hand at end of period	93,171	89,727	93,131
Southern District†			
Stocks on hand at beginning of period	40,807	49,004	43,727
Produced in establishments reporting	437,950	377,232	446,139
Purchased*	210,270	132,383	240,197
Total	689,027	558,619	730,063
Consumed in making fertilizers	531,413	402,584	547,922
Sales:			
To fertilizer works	83,140	78,518	103,101
To other than fertilizer works	31,692	32,750	35,484
Stocks on hand at end of period	42,782	44,767	43,556
Northern and Western Districts†			
Stocks on hand at beginning of period	44,901	48,039	42,520
Produced in establishments reporting	439,842	401,847	364,187
Purchased*	156,234	134,528	173,639
Total	640,977	584,414	580,346
Consumed in making fertilizers	512,420	451,304	424,884
Sales:			
To fertilizer works	39,067	38,683	51,978
To other than fertilizer works	39,101	49,467	53,909
Stocks on hand at end of period	50,389	44,960	49,575

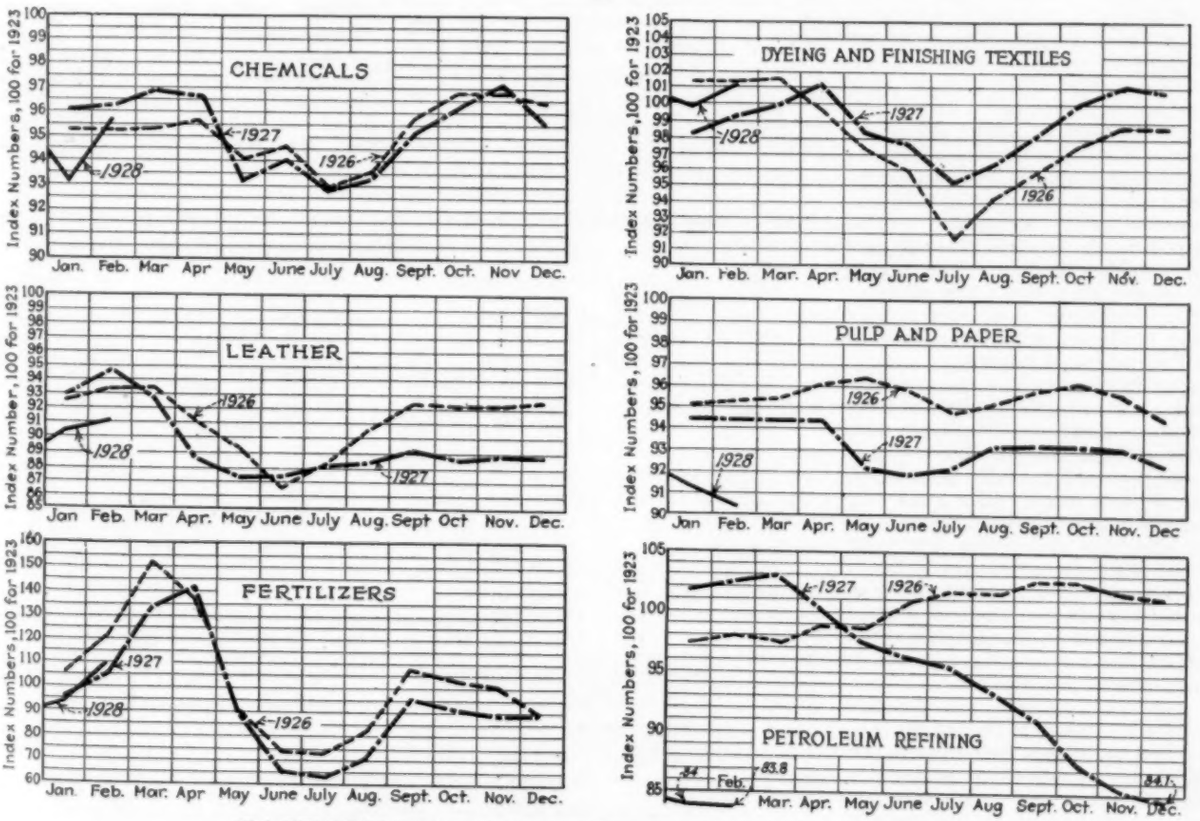
*Transfers from and transfers to other plants of the same company are reported as purchases and sales, respectively.

†Southern District comprises States south of the Virginia-North Carolina line, viz., Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Oklahoma, and Texas. Northern and Western Districts comprise all other States.

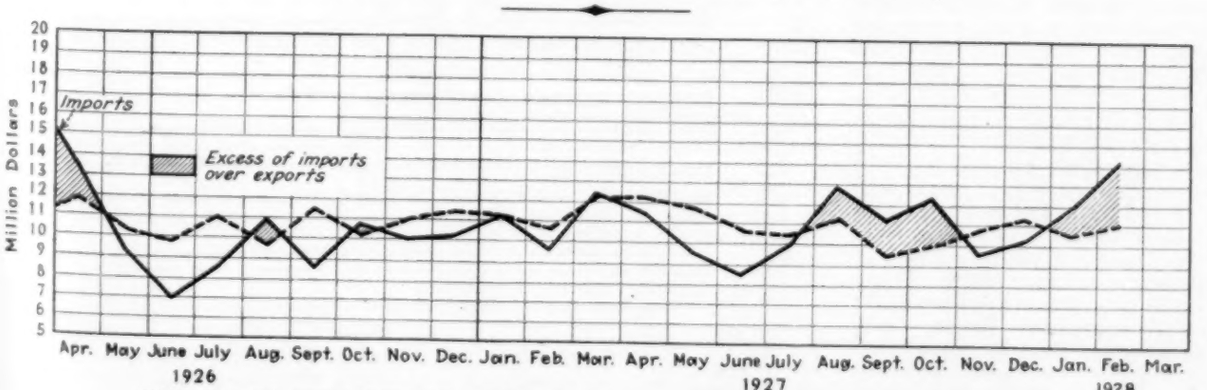
INDEXES OF ACTIVITY IN PRODUCING AND CONSUMING INDUSTRIES



VOLUME OF PRODUCTION *(U. S. Dept. of Commerce)*



FACTORY EMPLOYMENT *(U. S. Dept. of Labor)*


Million Dollars
Imports
Excess of imports over exports
Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar.
1926
1927
1928

FOREIGN TRADE IN CHEMICALS AND ALLIED PRODUCTS

MARKET CONDITIONS *and* PRICE TRENDS

Foreign Chemicals Exert Influence on Domestic Markets

REFERENCE to the latest detailed figures covering imports of chemicals, those for February, show that foreign producers are shipping in quantities large enough to offer keen competition in many selections. The importance of this as a price factor was recently demonstrated in a lowering of prices for chlorate of soda. Domestic sellers took this action in order to protect their market. For a long time foreign-made sal ammoniac was imported in large amounts and offered competition which resulted in a steadily declining price trend. Domestic sal ammoniac now seems to dominate the market as offerings of the foreign product have not been free in the last month and there has been a marked falling off in importations. The scarcity of domestic sulphate of ammonia has opened up a wider outlet for foreign sulphate and importations are increasing. The strong position of imported barium carbonate is evidenced by the fact that a higher import duty was made effective during the month in an attempt to give domestic producers a better chance to obtain their share of the trade.

Trading in chemicals in recent weeks has been on the up-grade. Export buying aided the movement of caustic soda and soda ash but domestic buyers have been taking their full allotments. Acetate of soda has found a good outlet, but sales are restricted because of limited offerings and prices are comparatively high. Some inquiry is heard for white arsenic, but there has been no active call for calcium arsenate and in spite of reports of large weevil emergence, the outlook for arsenate is doubtful.

SULPHUR seems to be firmly entrenched at current price levels and shipments from producing points are running to large volume with export buying accounting for a large tonnage. The fertilizer trade continues to consume larger amounts of sulphuric acid than it did last year and acid makers are disposing of their outputs. Higher costs for raw materials have resulted in stronger markets for tartaric and citric acids with similar conditions reported in foreign producing centers.

Coal-tar chemicals are reported to be moving in a normal way. Cresylic acid is not offered freely and as foreign producers are not able to offer in a large way, the situation gives no promise of improvement in the near future. Toluol has been in good demand and producers are not carrying surplus stocks. Creosote oil also has been in request and prices are firmly maintained. Naphthalene is practically sold ahead at present and spot prices are tending upward.

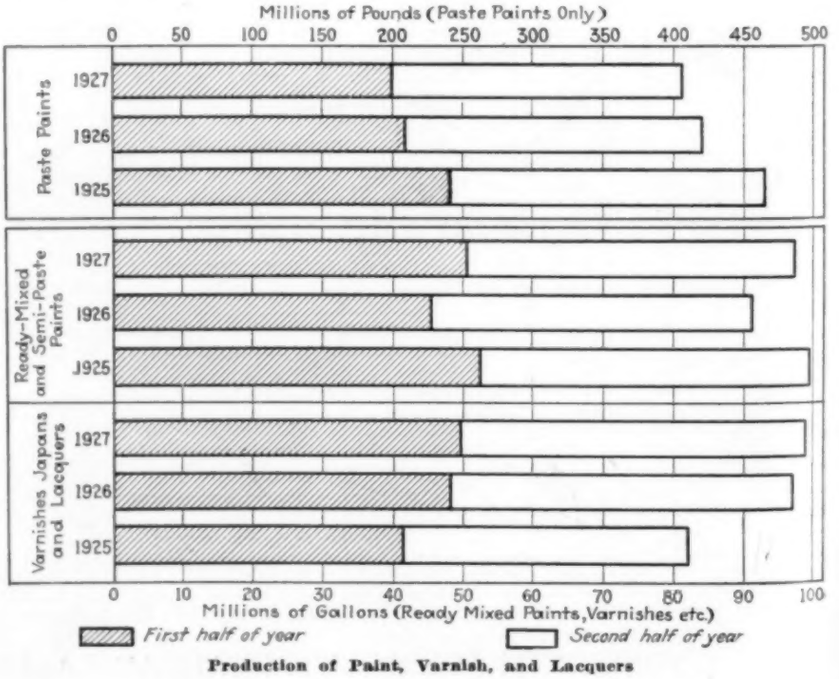
Disappearance of refined cottonseed oil in March was placed at 375,000 bbl. which proves that consumers are buying heavily and estimates of the carryover for this year are being revised downward. The supply, however, is still large and much will depend on the amount of seed produced from the coming cotton crop. Linseed oil is not active as far as new business is concerned but there is a steady delivery against old contracts. China wood oil has moved more freely from the interior of China and values have eased off under the increase in offerings.

Paint Production in Last Half of 1927

THE Department of Commerce announces that, according to data collected at the latest semi-annual canvass of paint and varnish manufacturers, the production during the six-months' period from July 1 to Dec. 31, 1927, was as follows: 206,863,800 lb. of paste paints, comprising 138,537,900 lb. of pure white lead in oil, 14,804,200 lb. of combination or graded whites, 3,845,300 lb. of zinc oxide in oil, and 49,676,400 lb. of other paste paints; 46,657,100 gal. of ready-mixed and semi-paste paints, including enamels; 33,404,700 gal. of varnishes, japans, and lacquers, other than pyroxylin; 15,890,500 gal. of pyroxylin varnishes or lacquers; and allied products comprising 760,800 gal. of paint and varnish removers, 2,082,100 gal. of stains, 491,000 gal. of liquid fillers, 7,906,600 lb. of paste fillers, and 32,420,100 lb. of putty.

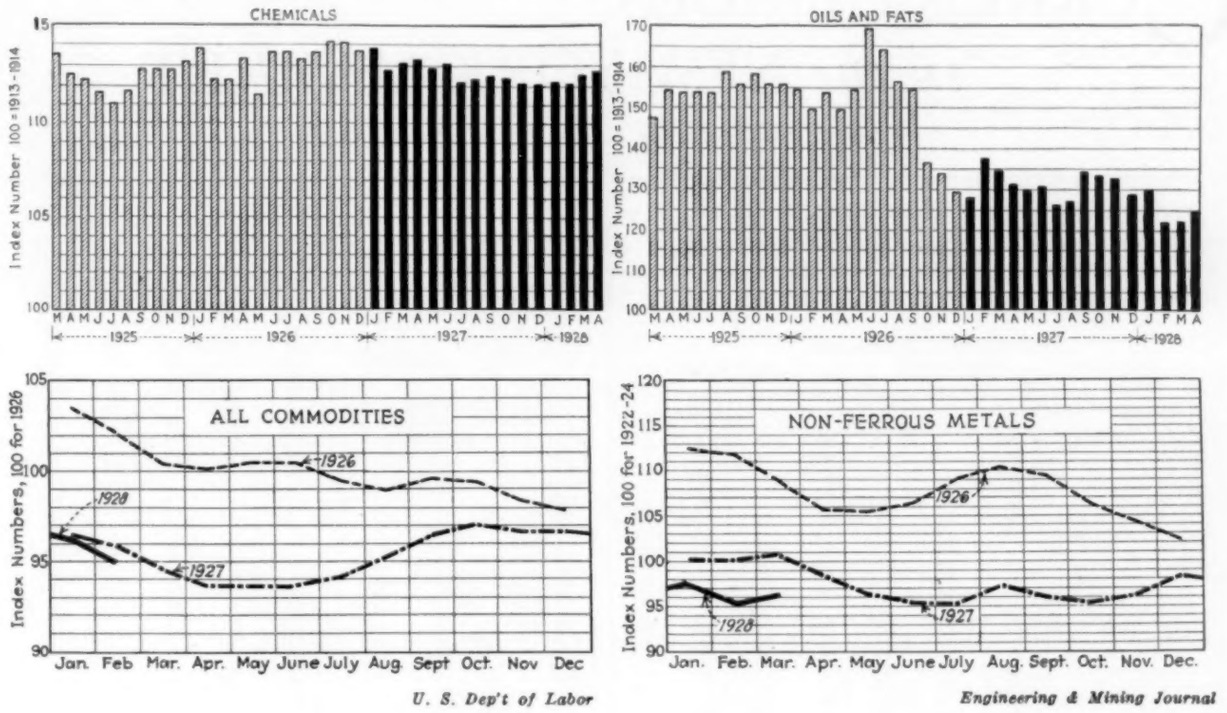
Table I.—Paint and Varnish Industry by Classes of Products, for Half-Year Periods 1922 to 1927

Period	Production: Paste Paints 1,000 Lb.	Production: Ready-Mixed and Semipaste Paints 1,000 Gal.	Production: Varnishes, Japans, and Lacquers 1,000 Gal.
1927—year	406 337	97 319	99 055
2nd half	206 864	46 657	49 295
1st half	199 473	50 662	49 760
1926—year	421 560	91 025	97 304
2nd half	212 537	45 623	49 086
1st half	209 023	45 402	48 218
1925—year	465 285	99 709	82 017
2nd half	224 228	47 260	40 622
1st half	241 057	52 449	41 395
1924—year	487 611	88 274	70 450
2nd half	233 867	43 152	34 301
1st half	253 744	45 122	36 149
1923—year	439 175	82 070	70 731
2nd half	192 021	38 351	32 849
1st half	247 154	43 719	37 882
1922—year	436 295	66 071	55 709
2nd half	227 703	33 440	28 877
1st half	208 592	32 631	26 832



Production of Paint, Varnish, and Lacquers

CHEM. & MET. *Weighted Indexes of* PRICES


CHEMICALS
Index Number 100 = 1913-1914
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A
1925
1926
1927
1928
OILS AND FATS
Index Number 100 = 1913-1914
ALL COMMODITIES
Index Numbers, 100 for 1926
1926
1928
1927
Jan. Feb. Mar. Apr. May June July Aug. Sept Oct. Nov Dec
U. S. Dep't of Labor
NON-FERROUS METALS
Index Numbers, 100 for 1922-24
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
Engineering & Mining Journal

Increased Demand for Chemicals Has Steadying Effect on Values

ENLARGED operations on the part of consuming industries resulted in a larger movement of chemicals in the last month and, with the practical elimination of selling pressure, a firmer price tone prevailed. The more important raw materials which are used in the manufacture of chemicals appear to be well established around present price levels and the most important factor on the future course of values for chemicals rests with the actvity of consumers.

Among the important price changes during the month was the marking up in quotations for bichromates. Following price adjustments in the post-war period, fluctuations in prices for bichromates had been within very narrow limits even in the face of advancing production costs. Current revision of prices may be due to a belated recognition of higher markets for raw materials but is regarded as an indication that producers are abandoning the competition which has characterized the market for several years.

A sold-up condition still is reported for ammonia salts and no recessions in prices are probable for the near future. Citric and tartaric acids are higher, partly through higher costs of production and partly through the lessening of foreign competition. Alcohol, while unchanged for prompt shipment, has been marked up for later deliveries. Alkalies show some irregularity in price in the export trade, but domestic sales are on a fairly steady basis and deliveries to consumers have been large enough to prevent any accumulations in sellers' hands.

Production of calcium chloride has increased this year and there is a possibility that at least one more new producer may enter the field. Recent sales of this chemical have been on a basis favorable to buyers and prospects for continued competition give some uncertainty to future stability of prices. Oxalic acid, while holding a steady price level, is none too steady as reports are current that production is being enlarged to a point beyond consuming requirements which may lead to price-cutting among sellers. Mineral acids are in a firm position although there is some doubt about the effect an enlarged production of nitric acid through the ammonia-oxidation method, may have on future values.

WITH the active crushing season over, the supply of crude cottonseed oil is more firmly held and this has had the effect of raising the weighted index number for oils and fats. Refined cottonseed oil has not advanced in the same proportion as the crude product and with the large supply on hand, higher prices would be warranted only by unfavorable developments in the coming cotton crop. Linseed oil has not moved as freely as had been expected and crushers have offered inducements, but any decided price trend will depend upon the Argentine markets. China wood oil has eased off in primary markets and this was reflected in prices quoted to domestic buyers. Coconut and palm oils have shown but little change, but tallow and animal fats were easy at times during the month.

Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1913-14

This month	**124.90**
Last month	122.35
April, 1927	131.67
April, 1926	149.09

Price movements were irregular with lower values prevailing for tallow, oleo oil and other fats but higher prices governed trade in cottonseed oil and other vegetable oils except linseed and china wood were in a firm position.

Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1913-14

This month	**112.72**
Last month	112.60
April, 1927	113.34
April, 1926	113.25

A slightly higher price level was found in the market for chemicals. Producers advanced values for citric and tartaric acids. Bichromates also were moved up during the interval. Alcohol was higher for deferred deliveries.

CURRENT PRICES *in the* NEW YORK MARKET

For Chemicals, Oils and Allied Products

The following prices refer to round lots in the New York Market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to April 16.

Industrial Chemicals

		Current Price	Last Month	Last Year
Acetone, drums	lb.	$0.13 -$0.14	$0.13 -$0.14	$0.12 -$0.13
Acid, acetic, 28%, bbl.	cwt.	3.38 - 3.63	3.38 - 3.63	3.38 - 3.63
Boric, bbl.	lb.	.08½- .08¾	.08½- .08¾	.08½- .08¾
Citric, kegs	lb.	.46 - .47	.44½- .45	.43½- .45
Formic, bbl.	lb.	.11 - .12	.11 - .12	.10½- .11
Gallic, tech., bbl.	lb.	.50 - .55	.50 - .55	.50 - .55
Hydrofluoric 30% carb.	lb.	.06 - .07	.06 - .07	.06 - .07
Lactic, 44%, tech., light, bbl.	lb.	.13 - .14	.13 - .14	.13½- .14
22%, tech., light, bbl.	lb.	.06 - .07	.06 - .07	.06¼- .07
Muriatic, 18°, tanks	cwt.	.85 - .90	.85 - .90	.85 - .90
Nitric, 36°, carboys	lb.	.05 - .05½	.05 - .05½	.05 - .05½
Oleum, tanks, wks.	ton	18.00 -20.00	18.00 -20.00	18.00- 20.00
Oxalic, crystals, bbl.	lb.	.11 - .11¼	.11 - .11¼	.11 - .11¼
Phosphoric, tech., c'bys.	lb.	.08½- .09	.08½- .09	.08½- .09
Sulphuric, 60°, tanks	ton	11.00 -11.50	11.00 -11.50	10.50 -11.00
Tannic, tech., bbl.	lb.	.35 - .40	.35 - .40	.35 - .40
Tartaric, powd., bbl.	lb.	.38 - .38½	.36 - .37	.33 - .34
Tungstic, bbl.	lb.	1.00 - 1.20	1.00 - 1.20	1.00 - 1.20
Alcohol, ethyl, 190 n'f., bbl.	gal.	2.70½- 2.75	2.70½- 2.75	4.85 - 4.90
Alcohol, Butyl, dr.	lb.	.19 - .20	.19 - .20	.20 - .20½
Denatured, 190 proof				
No. 1 special dr.	gal.	.43 -.....	.43	.37½-.....
No. 5, 188 proof, dr.	gal.	.43 -.....	.43	.37½-.....
Alum, ammonia, lump, bbl.	lb.	.03½- .04	.03½- .04	.03½- .04
Chrome, bbl.	lb.	.05½- .05¾	.05¼- .05½	.05½- .06
Potash, lump, bbl.	lb.	.02½- .03¼	.02½- .03¼	.02½- .03¼
Aluminum sulphate, com., bags	cwt.	1.40 - 1.45	1.40 - 1.45	1.40 - 1.45
Iron free, bg.	cwt.	2.00 - 2.10	2.00 - 2.10	2.00 - 2.10
Aqua ammonia, 26°, drums	lb.	.03 - .04	.03 - .04	.02½- .03
Ammonia, anhydrous, cyl.	lb.	.13¾-.....	.13¾-.....	.11 - .13
Ammonium carbonate, powd., tech., casks	lb.	.10½- .14	.10½- .14	.10½- .14
Sulphate, wks.	cwt.	2.60 -.....	2.40	2.45 -.....
Amylacetate tech., drums	gal.	1.75 - 2.00	1.75 - 2.00	2.15 - 2.20
Antimony Oxide, bbl.	lb.	.13½- .15	.13¼- .15	.16½- .17
Arsenic, white, powd., bbl.	lb.	.04 - .04½	.04 - .04¼	.03½- .04½
Red, powd., kegs	lb.	.09 - .10	.09½- .10	.10½- .11
Barium carbonate, bbl.	ton	48.00 -50.00	48.00 -50.00	47.00 -50.00
Chloride, bbl.	ton	55.00 -58.00	55.00 -.....	57.00 -.....
Nitrate, cask	lb.	.08 - .08½	.08 - .08¼	.07½- .08
Blanc fixe, dry, bbl.	lb.	.04 - .04½	.04 - .04½	.04 - .04¼
Bleaching powder, f.o.b., wks., drums	cwt.	2.00 - 2.10	2.00 - 2.10	2.00 - 2.10
Borax, bbl.	lb.	.04 - .04½	.04 - .04½	.04½- .04½
Bromine, cs.	lb.	.45 - .47	.45 - .47	.45 - .47
Calcium acetate, bags	cwt.	3.50 -.....	3.50 -.....	3.50 -.....
Arsenate, dr.	lb.	.06½- .07	.06½- .07	.06½- .07
Carbide drums	lb.	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., wks.	ton	20.00 -	20.00 -	21.00 -
Phosphate, bbl.	lb.	.07 - .07½	.07 - .07½	.07 - .07½
Carbon bisulphide, drums	lb.	.05 - .06	.05½- .06	.05½- .06
Tetrachloride drums	lb.	.06½- .07	.06½- .07	.06½- .07
Chlorine, liquid, tanks, wks.	lb.	.03¼- .04½	.03½- .04½	.04 - .04½
Cylinders	lb.	.05½- .08	.05½- .08	.05½- .08
Cobalt oxide, cans	lb.	2.10 - 2.20	2.10 - 2.20	2.10 - 2.25
Copperas, bgs., f.o.b. wks.	ton	16.00 -17.00	16.00 - 17.00	15.00 -16.00
Copper carbonate, bbl.	lb.	.17 - .17½	.17 - .18	.17 - .18
Cyanide, tech., bbl.	lb.	.49 - .50	.49 - .50	.49 - .50
Sulphate, bbl.	cwt.	5.05 - 5.10	5.05 - 5.10	4.80 - 4.90
Cream of tartar, bbl.	lb	.25½- .26	.27½- .28	.22 - .23
Diethylene glycol, dr.	gal.	.10 - .15	.10 - .15	..... - .....
Epsom salt, dom., tech., bbl.	cwt.	1.75 - 2.15	1.75 - 2.00	1.75 - 2.00
Imp., tech., bags	cwt.	1.15 - 1.25	1.15 - 1.25	1.35 - 1.40
Ethyl acetate, 85% drums	gal.	.74 - .76	.74 - .76	.74 - .76
Formaldehyde, 40%, bbl.	lb.	.08½- .08¾	.08½- .11¼	.11½- .11¾
Furfural, dr.	lb.	.15 - .17½	.15 - .17½	.15 - .17
Fusel oil, crude, drums	gal.	1.30 - 1.40	1.30 - 1.40	1.40 - 1.50
Refined, dr.	gal.	2.50 - 3.00	2.50 - 3.00	2.50 - 3.00
Glaubers salt, bags	cwt.	1.10 - 1.20	1.00 - 1.10	1.00 - 1.10
Glycerine, c.p., drums, extra	lb.	.15 - .15½	.17 - .18	.26 -.....
Lead:				
White, basic carbonate, dry, casks	lb.	.08¾-	.08¾-	.09¾- .....
White, basic sulphate, sck.	lb.	.07½-	.07½-	.09½- .....
Red, dry, sck.	lb.	.09¼-	.09½-	.10¼- .....
Lead acetate, white crys., bbl.	lb.	.13 - .13¾	.13 - .13¼	.14¼- .....
Lead arsenate, powd., bbl.	lb.	.12 - .13	.12 - .13	.14 - .15
Lime, chem., bulk	ton	8.50 -.....	8.50 -.....	8.50 -.....
Litharge, pwd., csk.	lb.	.08¼-	.08¼-	.10 -.....
Lithopone, bags	lb.	.05¼- .06	.05¼- .06	.05¼- .06½
Magnesium carb., tech., bags	lb.	.07¼- .08	.07¼- .08	.07½- .08
Methanol, 95%, dr.	gal.	.43 - .45	.43 - .45	.83 - .85
97%, dr.	gal.	.45 - .47	.45 - .47	.85 - .87
Nickel salt, double, bbl.	lb.	.10 - .10¼	.10 - .10¼	.10 - .10
Single, bbl.	lb.	.10¼- .11	.10¼- .11	.10¼- .11¼
Orange mineral, csk.	lb.	$0.11¼-..	$0.11¼-	$0.12½- .....
Phosphorus, red, cases	lb.	.62 - .65	.62 - .65	.62 - .65
Yellow, cases	lb.	.32 - .33	.32 - .34	.32 - .33
Potassium bichromate, casks	lb.	.08¼- .08½	.08¼- .08¼	.08½- .08¾
Carbonate, 80-85%, calc., csk.	lb	.05½- .06	.05½- .06	.05½- .06
Chlorate, powd.	lb.	.08¼- .09	.08¼- .09	.08¼- .09
Cyanide, cs.	lb.	.55 - .57	.55 - .58	.55 - .57
First sorts, csk.	lb.	.09 - .09½	.08½- .09	.08½- .09
Hydroxide(c'stic potash)	dr. lb.	.07½- .07¾	.07½- .07¾	.07½- .07¾
Muriate, 80% bgs.	ton	36.40 -	36.40 -	36.40 -
Nitrate, bbl.	lb.	.06 - .06½	.06 - .06¼	.06 - .07½
Permanganate, drums	lb.	.15 - .16	.15 - .16	.14 - .15
Prussiate, yellow, casks	lb.	.18 - .19	.18 - .19	.18½- .19
Sal ammoniac, white, casks	lb.	.047- .05	.047- .05	.05½- .06
Salsoda, bbl.	cwt.	.90 - .95	.90 - .95	.90 - .95
Salt cake, bulk	ton	17.00 -18.00	17.00 -18.00	17.00 -19.00
Soda ash, light, 58%, bags, contract	cwt.	1.32 -.....	1.32 -.....	1.32½-.....
Dense, bags	cwt.	1.35 -.....	1.35 -.....	1.37½-.....
Soda, caustic, 76%, solid, drums, contract	cwt.	2.80 - 3.00	2.80 - 3.00	3.00 - 3.10
Acetate, works, bbl.	lb.	.05½- .06	.05 - .05¼	.04¼- .05
Bicarbonate, bbl.	cwt.	2.00 - 2.25	2.00 - 2.25	2.00 - 2.25
Bichromate, casks	lb.	.07 - .07½	.06¼- .06½	.06½- .06½
Bisulphate, bulk	ton	3.00 - 3.50	5.00 - 5.50	5.00 - 5.50
Bisulphite, bbl.	lb.	.03½- .04	.03½- .04	.03¼- .04
Chlorate, kegs	lb.	.05½- .06	.05½- .06	.06½- .06½
Chloride, tech.	ton	12.00 -14.75	12.00- 14.75	12.00 -14.00
Cyanide, cases, dom.	lb.	.18 - .22	.18 - .22	.18 - .22
Fluoride, bbl.	lb.	.09 - .09½	.09 - .09½	.09½- .10
Hyposulphite, bbl.	lb.	2.50 - 3.00	2.50 - 3.00	2.50 - 3.00
Nitrate, bags	cwt	2.35 -.....	2.35 -.....	2.65 -.....
Nitrite, casks	lb.	.07½- .08	.07½- .08	.08 - .08½
Phosphate, dibasic, bbl.	lb.	.03 - .03½	.03¼- .03½	.03¼- .03½
Prussiate, yel. drums	lb.	.11½- .12	.12 - .12¼	.12 - .12½
Silicate (30°, drums)	cwt.	.75 - 1.15	.75 - 1.15	.75 - 1.15
Sulphide, fused, 60-62%, dr.	lb.	.03½- .04	.03½- .04	.03½- .04
Sulphite, crys., bbl.	lb.	.03 - .03½	.03 - .03½	.02½- .03
Strontium nitrate, bbl.	lb.	.09 - .09½	.08½- .09	.08½- .09
Sulphur, crude at mine, bulk	ton	18.00 -.....	18.00 -.....	18.00 -.....
Chloride, dr.	lb.	.04 - .05	.04 - .05	.05 - .05½
Dioxide, cyl.	lb.	.09 - .10	.09 - .10	.09 - .10
Flour, bag	cwt.	2.70 - 3.00	2.70 - 3.00	2.70 - 3.00
Tin bichloride, bbl.	lb.	.15½-	.15½-	.19½- .....
Oxide, bbl.	lb.	.56 -.....	.57 -.....	.70 -.....
Crystals, bbl.	lb.	.39 -.....	.38½-	.47 -.....
Zinc chloride, gran., bbl.	lb.	.06½- .06¾	.06½- .06¾	.06½- .06¾
Carbonate, bbl.	lb.	.10 - .11	.10 - .10¼	.10½- .11
Cyanide, dr.	lb.	.40 - .41	.40 - .41	.40 - .41
Dust, bbl.	lb.	.09 - .10	.09 - .10	.10½- .11
Zinc oxide, lead free, bag.	lb.	.06½-	.06½-	.06½- .....
5% lead sulphate, bags	lb.	.06½-	.06½-	.06½- .....
Sulphate, bbl.	cwt	2.75 - 3.00	2.75 - 3.00	3.00 - 3.10

Oils and Fats

		Current Price	Last Month	Last Year
Castor oil, No. 3, bbl.	lb.	$0.13½ $0.14	$0.13½-$0.14	$0.13½-$0.14
Chinawood oil, bbl.	lb.	.15½	17 -.....	32 -.....
Coconut oil, Ceylon, tanks, N. Y.	lb.	.08½-	08¼-.	08¼- .....
Corn oil crude, tanks, (f.o.b. mill)	lb.	09¼	08¼	07½- .....
Cottonseed oil, crude (f.o.b. mill), tanks	lb.	.08¾	07½-	.07½- .....
Linseed oil, raw, car lots, bbl.	lb.	096	098	103- .....
Palm, Lagos, casks	lb.	07¼	07¼-	07½- .....
Niger, casks	lb.	07¼	07½- .07¾	07½- .....
Palm Kernel, bbl.	lb.	09¼	09¼-	09 -.....
Peanut oil, crude, tanks(mill)	lb.	09¼	09¼-	12½- .....
Perilla, bbl	lb.	.....	.....	.....
Rapeseed oil, refined, bbl.	gal	.85 - 86	85 - 86	80 - .82
Sesame, bbl.	lb.	.....	.....	.....
Soya bean tank (f.o.b. Coast)	lb	09¼	09¼-	10 -.....
Sulphur(olive foots), bbl.	lb	09¼	09¼	09½- .....
Cod, Newfoundland, bbl.	gal.	66 - 67	66 - 67	63 - 65
Menhaden, light pressed, bbl.	gal.	60 - 66	60 - 62	60 - 62
Crude, tanks(f.o.b. factory)	gal	40 -	40 -	45 -.....
Whale, crude, tanks	lb.	.....	.....	.....
Grease, yellow, loose	lb.	06½	06½	06½- .....
Oleo stearine	lb.	11¼	09¼	09½- .....
Red oil, distilled, d.p. bbl.	lb.	09½- .09¾	09¼- 09½	09½- 10
Tallow, extra, loose	lb.	08¼	08¼	07½- .....

Coal-Tar Products

		Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl.	lb.	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl.	lb.	.85 - .90	.85 - .90	.85 - .90
Alpha-naphthylamine, bbl.	lb.	.35 - .36	.35 - .36	.35 - .36
Aniline oil, drums, extra	lb.	.15 - .16	.15 - .16	.15 - .16
Aniline salts, bbl.	lb.	.24 - .25	.24 - .25	.24 - .25
Anthracene, 80%, drums	lb.	.60 - .65	.60 - .65	.60 - .65

Coal Tar Products (Continued)

		Current Price	Last Month	Last Year
Benzaldehyde, U.S.P., dr.	lb.	1.15 - 1.25	1.15 - 1.35	1.15 - 1.25
Benzidine base, bbl.	lb.	.70 - .72	.70 - .75	.70 - .72
Benzoic acid, U.S.P., kgs.	lb.	.58 - .60	.58 - .60	.58 - .60
Benzyl chloride, tech, dr.	lb.	.25 - .26	.25 - .26	.23 - .24
Benzol, 90%, tanks, works	gal.	.21 - .22	.21 - .22	.24 - .25
Beta-naphthol, tech., drums	lb.	.22 - .24	.22 - .24	.22 - .24
Cresol, U.S.P., dr.	lb.	.18 - .20	.18 - .20	.18 - .20
Cresylic acid, 97%, dr., wks.	gal.	.73 - .75	.73 - .75	.61 - .62
Diethylaniline, dr.	lb.	.58 - .60	.58 - .60	.58 - .60
Dinitrophenol, bbl.	lb.	.31 - .35	.31 - .33	.31 - .35
Dinitrotoluen, bbl.	lb.	.17 - .18	.17 - .18	.17 - .18
Dip oil, 25% dr.	gal.	.28 - .30	.28 - .30	.28 - .30
Diphenylamine, bbl.	lb.	.45 - .47	.45 - .47	.45 - .47
H-acid, bbl.	lb.	.63 - .65	.63 - .65	.63 - .65
Naphthalene, flake, bbl.	lb.	.05 - .06	.04½ - .05	.05½ - .06
Nitrobenzene, dr.	lb.	.08½ - .10	.09 - .10	.09 - .10
Para-nitraniline, bbl.	lb.	.52 - .53	.52 - .53	.50 - .53
Para-nitrotoluine, bbl.	lb.	.28 - .32	.28 - .32	.40 - .42
Phenol, U.S.P., drums	lb.	.17 - .18	.18 - .19	.17 - .18
Picric acid, bbl.	lb.	.30 - .40	.30 - .40	.25 - .26
Pyridine, dr.	lb.	3.00 -	3.00 -	3.90 - 4.00
R-salt, bbl.	lb.	.47 - .50	.47 - .50	.47 - .50
Resorcinal, tech, kegs.	lb.	1.30 - 1.35	1.35 - 1.40	1.30 - 1.40
Salicylic acid, tech., bbl.	lb.	.30 - .32	.30 - .32	.30 - .32
Solvent naphths, w.w.,tanks	gal.	.35 -	.35 -	.35 - .....
Tolidine, bbl.	lb.	.95 - .95	.95 - .96	.90 - .95
Toluene, tanks, works	gal.	.35 -	.35 -	.35 - .....
Xylene, com., tanks	gal.	.36 - .41	.36 - .41	.36 - .40

Miscellaneous

		Current Price	Last Month	Last Year
Barytes, grd., white, bbl.	ton	$23.00-$25.00	$23.00-$25.00	$23.00-$25.00
Casein, tech., bbl.	lb.	.16 - .18	.16 - .18	.15 - 16
China clay, dom.,f.o.b. mine	ton	10.00 -20.00	10.00 -20.00	10.00 -20.00
Dry colors:				
Carbon gas, black (wks.)	lb.	.06½- .07	.06½- .07	.08 - 08½
Prussian blue, bbl.	lb.	.31 - .33	.31 - .33	.33 - .34
Ultramine blue, bbl.	lb.	.08 - .35	.08 - .35	.08 - .35
Chrome green, bbl.	lb.	.27 - .31	.27 - .30	.27 - 30
Carmine red, tins	lb.	5.50 - 5.75	5.50 - 5.75	5.00 - 5.10
Para toner.	lb.	.70 - .80	.70 - .80	.80 - .90
Vermilion, English, bbl.	lb.	1.80 - 1.85	1.80 - 1.85	1.45 - 1.50
Chrome yellow, C. P., bbl.	lb.	.17 - .18	.17 - .18	.17½ - .18
Feldspar, No. 1 (f.o.b. N. C.)	ton	5.75 - 7.00	5.75 - 7.00	6.00 - 6.50
Graphite, Ceylon, lump, bbl	lb.	.07½ - .08	.07½ - .09½	.08 - .09
Gum copal, Congo, bags.	lb.	.07½ - .08	.07½ - .08	.09½ - .10
Manila, bags.	lb.	.15 - .18	.15 - .16	.15 - .18
Damar, Batavia, cases.	lb.	.23 - .24	.23 - .24	.25 - .25
Kauri, No. 1 cases.	lb.	.48 - .53	.48 - .53	.55 - .57
Kieselguhr (f.o.b. N. Y.)	ton	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc.	ton	44.00 -.....	44.00 -.....	44.00 -.....
Pumice stone, lump, bbl.	lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks.	lb.	.03 - .40	.03 - .40	.03 - .35
Rosin, H.	bbl.	9.90 -.....	9.75 -.....	11.00 -.....
Turpentine	gal.	.58 -.....	.60 -.....	.68 -.....
Shellac, orange, fine, bags	lb.	.51 - .52	.51 - .52	.38 - .39
Bleached, bonedry, bags.	lb.	.54 - .56	.54 - .56	.47 - .50
T. N. bags.	lb.	.44 - .45	.44 - .45	.37 - .38
Soapstone (f.o.b. Vt.), bags.	ton	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.)	ton	10.50 -.....	10.50 -.....	11.00 -.....
200 mesh (f.o.b. Ga.)	ton	7.50 -10.00	7.50 -10.00	7.50 -11.00
325 mesh (f.o.b. N. Y.)	ton	13.75 -.....	13.75 -.....	14.75 -.....

		Current Price	Last Month	Last Year
Wax, Bayberry, bbl.	lb.	$0.23½ $0.24	$0.23½ $0.26	$0.25 $0.26
Beeswax, ref., light	lb.	.43 - .45	.43 - .47	.45 - .46
Candelilla, bags	lb.	.25 - .27	.25 - .27	.33 - .34
Carnauba, No. 1, bags	lb.	.54 - .55	.54 - .55	.65 - .70
Paraffine, crude 105-110 m.p.	lb.	.04½ .05	.04½ - .05	.05½ .06

Ferro-Alloys

		Current Price	Last Month	Last Year
Ferrotitanium, 15-18%	ton	$200.00-.....	$200.00-.....	$200.00-.....
Ferromanganese, 78-82%	ton	100.00-.....	100.00-.....	100.00-90.00
Spiegeleisen, 19-21%	ton	31.00-32.00	31.00-32.00	36.00-37.00
Ferrosilicon, 10-12%	ton	33.00-38.00	33.00-38.00	33.00-38.00
Ferrotungsten, 70-80%	lb.	.90 - .95	.90 - .95	.98 - 1.05
Ferro-uranium, 35-50%	lb.	4.50-.	4.50-.	4.50-.
Ferrovanadium, 30-40%	lb.	3.15- 3.75	3.15- 3.75	3.15- 3.75

Non-Ferrous Metals

		Current Price	Last Month	Last Year
Copper, electrolytic	lb.	$0.14½-.....	$0.14½ -.....	$0.13 -.....
Aluminum, 96-99%	lb.	.24 - .26	.24 - .26	.26 - .28
Antimony, Chin. and Jap.	lb.	.10 - .11	.10½ - .11	.13½-...15
Nickel, 99%	lb.	.33 -.....	.35 -.....	.35 -.....
Monel metal, blocks	lb.	.32 - .33	.32 - .33	.32 - .33
Tin, 5-ton lots, Straits	lb.	51½-.....	51½ -.....	68 -.....
Lead, New York, spot	lb.	6.10 -.....	6.00 -.....	7.15 -.....
Zinc, New York, spot	lb.	6.05 -.....	6.00 -.....	6.72 -.....
Silver, commercial	oz.	.57½-.....	.57½ -.....	.56½-.....
Cadmium	lb.	.60 -	.60 -	.60 -
Bismuth, ton lots	lb.	1.85 - 2.10	1.85 - 2.00	2.20 - 2.25
Cobalt	lb.	2.50 -	2.50 -	2.50 -
Magnesium, ingots, 99%	lb.	.75 - .80	.75 - .80	.75 - .80
Platinum, ref.	oz.	85.00-	85.00-	108.00-
Palladium, ref.	oz.	50.00- 52.00	50.00- 52.00	59.00-63.00
Mercury, flask 75	lb.	124.50	120.50-	104.00-.....
Tungsten powder.	lb.	1.05- 1.15	1.05-	1.05-....

Ores and Semi-finished Products

		Current Price	Last Month	Last Year
Bauxite, crushed, wks.	ton	$5.50- $8.50	$5.50- $8.50	$5.50- $8.75
Chrome ore, c.f. post.	ton	22.00- 24.00	22.00- 24.00	22.00- 23.00
Coke, fdry., f.o.b. ovens	ton	2.85- 3.00	2.85 3.00	3.25- 3.75
Fluorspar, gravel, f.o.b. Ill.	ton	14.50-.....	14.50	18.00-.....
Ilmenite, 52% TiO_2, Va.	lb.	.00½ - .00½	.00½- .00½	.00½- -
Manganese ore, 50% Mn., c.i.f. Atlantic Ports	unit	36 - 38	36 - 38	.36 - 38
Molybdenite, 85% MoS_2 per lb. MoS_2, N. Y.	lb.	.48 - .50	.48 - 50	.48- .50
Monazite, 6% of ThO_2	ton	120.00-.....	120.00-.....	120.00-.....
Pyrites, Span. fines, c.i.f.	unit	.13½-.....	.13½-.....	.13½-.....
Rutile, 94-96% TiO_2	lb.	.11 - .13	.11 - .13	.11 - .13
Tungsten, scheelite, 60% WO_3 and over	unit	10.50 -10.75	10.50 -10.75	11.25 -11.50
Vanadium ore, per lb. V_2O_5	lb.	.25 - .28	.25 - .30	.25 - .28
Zircon, 99%	lb.	.03 -.....	.03 -.....	.03 -.....

CURRENT INDUSTRIAL DEVELOPMENTS

New Construction and Machinery Requirements

Ale Cooling Plant — British American Brewing Co., Sandwich St. W., Windsor, Ont., awarded contract for a 3 story, 55 x 75 ft. ale cooling plant to Gosselin Construction Co., Peter St., Sandwich, Ont. Estimated cost $80,000. Special refrigeration equipment, tanks, piping, etc. will be installed.

Aluminum Products Factory—Bohn Aluminum & Bronze Co., Isobel St., Detroit, Mich., plans the construction of a 1 story, 50 x 316 ft. addition to aluminum products factory. C. W. Brandt, 1016 Francis Palms Bldg., Detroit, Mich., is architect. Equipment for finishing aluminum castings will be required.

Ammonia Distribution Plant — Robinson Bros. & Buffalo Ammonia Inc., W. A. Paul, Pres., Montrose and Seneca Ave., Brooklyn, N. Y., had plans prepared for a 1 story, 75 x 200 ft. ammonia distribution plant and warehouse at Randolph St. and Scott Ave. Estimated cost $100,000. H. C. Bracker, 2424 Myrtle Ave., Brooklyn, N. Y., is architect.

Boiler Compound Factory—Garratt & Calahan Co., 310 South Michigan Ave., Chicago, Ill., plans the construction of a 1 story, 97 x 119 ft. factory at 8931 State St., for the manufacture of boiler compounds. Estimated cost $30,000. F. E. Davidson, 53 West Jackson Blvd., Chicago, Ill., is architect.

Brass Foundry—Oklahoma City Brass Pipe Co., Oklahoma City, Okla., is having preliminary plans prepared for a 1 story foundry for the manufacture of brass castings and brass lined steel pipe. Estimated cost $50,000. Architect not selected. Equipment will be required.

Bronze Powder Factory — Aluminum Bronze Powder Co., P. J. Steigerwald, 1823 Columbus Rd., Cleveland, O., awarded contract for a 1 story, 36 x 80 ft. bronze powder factory at Bedford, O. to R. E. Nixon, 10006 Carnegie Ave., Cleveland, O. Estimated cost $40,000.

By-Products Plant—Pacific By-Products Co., San Jose, Calif., subsidiary of California Packing Corp., 101 California St., San Francisco, Calif., is having plans prepared for one 4 story and two 1 story buildings for by-products plant on Sunol St., San Jose, Calif. Estimated cost $40,000. Private plans.

By-Products Plant—Essential Products Co., Portersville, Calif., awarded contract for the construction of a 1 story, 30 x 70 ft. factory for the manufacture of peppermint and by-products, including menthol at Sacramento, Calif., to F. H. Bell, 1306 36th St., Sacramento, Calif.

Canning Plant Equipment—San Patricio Packing Co., Aransas Pass, Tex., prices and catalogs on machinery and equipment for proposed 45 x 330 ft. shrimp canning plant at Point Isabel, Tex. Estimated cost $75,000.

Carbon Black Plant—G. L. Cabot, Inc., 940 South Bldg., Boston, Mass., plans the construction of a carbon black plant, 30,000 lbs. daily capacity near Pampa, Tex. $500,000, also five additional units as needed at Skelltown a town near Pampa. Work will be done by owners' forces. Machinery and equipment including electric motors, presses, conveyors, etc. will be required.

Chemical Factory—J. T. Baker Chemical Co., Phillipsburg, N. J., plans the construction of a 120 x 200 ft. storage building, office, etc. for chemical factory. Baker & Spencer Inc., 117 Liberty St., New York, N. Y., are engineers.

Chemical Factory — National Pharmical Co., 5429 Dix Ave., Detroit, Mich., awarded contract for a 1 and 2 story, 60 x 146 ft. factory for the manufacture of chemicals on Scotten Ave. to A. R. Yops, 7411 Grand River Ave., Detroit, Mich. Estimated cost $45,000. Equipment will be installed.

Chemical Factory—Stauffer Chemical Co., A. Walter, V. Pres., New York, N. Y., has acquired a site near Ampthill and plans the construction of a factory for the manufacture of chemicals for use in the Viscose rayon factory at Roanoke, Va. Estimated cost $1,000,000.

Chemistry Building—State of New Hampshire, is having plans prepared for a 4 story, 60 x 155 ft. chemistry building at Durham, N. H. Estimated cost $225,000. E. T. Huddleston, Durham, N. H., is architect.

Chemistry Building — Texas Technical College, c/o A. P. Horn, Pres., Lubbock, Tex., will soon award contract for a 2 story, 106 x 233 ft. chemistry building. Estimated cost $240,000. W. C. Hedrick, 1005 First National Bank Bldg., Fort Worth, Tex., is architect.

Compressed Gas Plant—Linde Air Products Co., subsidiary National Carbon Co., 30 East 42nd St., New York, N. Y., awarded general contract for the construction of a compressed gas plant at Harrisburg, Pa. to Fred D. Groot Co., Harrisburg, Pa., also 130 x 300 ft. plant at Charleston, W. Va., to Stone & Webster, 147 Milk St., Boston, Mass. Estimated cost $1,000,000.

Compressed Gas and Oxygen Plants—Union Carbide & Carbon Co., c/o T. W. Goodrich, 30 East 42nd St., New York, N. Y., plans the construction of plants for the manufacture of oxygen at San Antonio, Tex. and Memphis, Tenn. for Linde Air Products Co., subsidiary, estimated cost including equipment $70,000 each, also plans to establish plants to manufacture compressed acetylene from calcium carbide at same locations for Presto-Lite-Co., subsidiary. Estimated cost $300,000.

Confectionery Factory—Hunts Ltd, 70 Alcorn Ave., Toronto, Ont., will soon receive bids for a 2 story addition to confectionery factory. Estimated cost $150,000. J. E. Walker, 82 King St. E., Toronto, Ont., is architect.

Cotton Compress Plant—Underwood Compress Co., Dallas, Tex., is having plans prepared for a 1 story, 225 x 600 ft. cotton compress plant at Hollis, Okla. Estimated cost $175,000. Architect not announced. Machinery and equipment will be required.

Cotton Seed Oil Mill—Southwestern Irrigation Cotton Growers Assn., G. Jones, Pres., El Paso, Tex., is having preliminary plans prepared for a cotton seed oil mill. Estimated cost $150,000. Complete machinery and equipment will be required.

Drug Factory—Ex-Lax Mfg. Co., M. Kiss, Treas, Atlantic Ave. and Nevins Sts., Brooklyn, N. Y., plans completed for addition to drug factory. H. A. Yarish, 46 Graham Ave., Brooklyn, N. Y., is architect.

Enamel Building — Columbia Steel Co., Div. of American Rolling Mills Co., Middletown, O., had preliminary plans prepared for addition to steel mill including shipping building, warehouse, cold mill building, and box enamel building at Butler, Pa. Estimated cost $2,000,000. Dwight P. Robinson Co. Inc., 125 East 46th St., New York, N. Y., is engineer.

Essential Oils Factory—A. N. Todd Co., Rose Ave., Kalamazoo, Mich., awarded contract for a 3 story factory for the manufacture of mint and essential oils on Kalamazoo Ave. to O. F. Miller Construction Co., Pratt Bldg., Kalamazoo, Mich. Estimated cost $45,000.

Fertilizer Plant—Xenia Fertilizer Co., Xenia, O., is having plans prepared for the construction of a fertilizer factory at Hook Rd. Estimated cost $35,000. Private plans.

Foil Factory—U. S. Foil Co., 30th and Grand Sts., Louisville, Ky., awarded contract for a 1 story, 113 x 200 ft. foil factory to J. E. Boswell, 1107 East Broadway, Louisville, Ky. Estimated cost $100,000.

Gas Plant—American Gas Construction Co., Newton, Ia., will build a gas plant to furnish light, heat and power at Willmar, Minn. Estimated cost $200,000.

Gas Plant—City of Cedar Falls, voted $150,000 bonds for the construction of a gas plant.

Gas Plant Extension—Nashville Gas & Heating Co., 226 6th Ave. N., Nashville, Tenn., plans to expend $200,000 in 1928 for extensions and improvements to gas producing units, etc.

Grinding and Polishing Mill—Pittsburgh Plate Glass Co., Frick Bldg., Pittsburgh, Pa., will build a 2 story, 80 x 1200 ft. grinding and polishing mill at Ford City, Pa. Estimated cost $2,000,000. Work will be done by separate contracts.

Gypsum Factory—U. S. Gypsum Co., S. L. Avery, Pres., 300 West Adams St., Chicago, Ill., plans the construction of ten factory buildings near Mystic Docks, Charlestown, Mass. Estimated cost $1,500,000. Private plans.

Laboratory—Mid-West Laboratories Inc., L. M. Thomas, Gen. Mgr., 209 South High St., Columbus, O., awarded contract for a 2 story, 40 x 40 ft. laboratory on Third Ave. to R. R. Orr, 265 Oakland Park Ave., Columbus, O. Estimated cost $25,000. Experimental oven, mixers, etc. for testing cereals of all kinds will be required.

Laboratory Equipment—Bd. of Education, G. W. Garner, Secy., Memphis, Tenn., will receive bids until Apr. 23 for laboratory equipment for Memphis Technical high school now under construction at Poplar Ave. and Claybrook St.

Laboratory Equipment—Bd. of Trustees, Ohio State University, C. E. Steeb, Secy., Columbus, O., will receive bids until Apr. 25, for laboratory equipment for new chemistry building.

Laboratory (Electrical and Mechanical) —Bd. of Trustees, Lehigh University, Bethlehem, Pa., awarded contract for the construction of an electrical and mechanical laboratory to Irvin & Leighton, 126 North 12th St., Philadelphia, Pa.

Laboratory (Research)—Cleveland Clinic Hospital, 8803 Euclid Ave., Cleveland, O., awarded contract for an 8 story, 24 x 74 ft. research laboratory at 2045 East 93rd St. to Crowell & Little Construction Co., Hanna Bldg., Cleveland, O. Estimated cost $300,000.

Laboratory (Research)—General Motors Corp., General Motors Bldg., Detroit, Mich., is having plans prepared for a 7 story, 210 x 230 ft. research laboratory on Second Blvd. A. Kahn, 1000 Marquette Bldg., Detroit, Mich., is architect. Equipment will be required later.

Laboratories, Etc.—Babies Hospital Association, 413 Military Park Bldg., Newark, N. J., is having plans prepared for a 3 story hospital and nurses home including laboratories, etc. on High St. Estimated cost $150,000. J. H. & W. C. Ely, 784 Broad St., Newark, N. J., are architects.

Lumber and Creosoting Plant—National Lumber and Creosoting Co., 312 Railway Exchange Bldg., Kansas City, Mo., plans first unit of lumber and creosoting plant capable of handling 6,000 cars of lumber per year at Wilmington, Del. Estimated cost $1,000,000. This corrects report of March issue.

Milk Products Plant—Eau Claire Milk Producers Co-operative Assn., Eau Claire, Wis., will receive bids about Apr. 15 for a 4 story milk products plant. Estimated cost $200,000. E. J. Hancock, Eau Claire, Wis., is architect. Douthitt Engineering Co., 139 North Clark St., Chicago, Ill., is engineer.

Mineral Grinding & Drying Plant—Metalloid Corp., D. H. Palmer, 53 West Jackson Blvd., Chicago, Ill., plans to expend $300,000 during the next two years for extensions and improvements to mineral grinding and drying plant to increase the capacity at 700 West Third St., Pueblo, Colo. Machinery and equipment including motors, grinders, etc. needed for the preparation of non-metallic minerals will be required.

Oxygen Gas Plant—Magnolia Gas Products Co., 506 South Medina St., San Antonio, Tex. and Houston, East and West Texas Ry., Houston, Tex., subsidiary of Southern Pacific Lines (Texas and Louisiana) R. W. Barnes, Ch. Engr., and International Great Northern Co., Houston, Tex., C. S. Kirkpatrick, Ch. Engr., joint owners, plan the construction of a 1 story oxygen gas plant at Walnut and Nebraska Sts., San Antonio, Tex. to cost $100,000. Machinery and equipment will be required.

Paint Factory—Van Sickle Glass & Paint Co., 138 South 10th St., Lincoln, Neb., awarded contract for a 2 story, 38 x 62 ft. paint factory at Third and L Sts. Estimated cost $30,000. Meginnis & Schaumberg, 614 Federal Trust Bldg., Lincoln, Neb., are architects.

Paper Mill—The Waxide Paper Co., 20th, Tracy and Berkowitz Ave., Kansas City, Mo. is having preliminary plans prepared for a 1 story, 150 x 280 ft. plant for the manufacture of wax paper with paraffin as base at Race Course and newstead Aves., St. Louis, Mo. Estimated cost $250,000.

Paper Mill Addition—Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich., awarded contract for a 2 story, 185 x 285 ft. addition to paper mill to O. F. Miller Construction Co., Pratt Bldg., Kalamazoo, Mich. Estimated cost $1,000,000.

Paper Mill Addition—Oxford Paper Co., 200 5th Ave., New York, N. Y., awarded contract for addition to paper mill at Rumford, Me. to J. Kerr, Rumford, Me. Estimated cost $125,000.

Petroleum Distribution Plants — Pacific Petroleum Products Co., subsidiary Petroleum Securities Co., Petroleum Securties Bldg., Los Angeles, Calif., is having plans prepared for the construction of a group of petroleum distribution plants, first will be located at Wisconsin and Arkansas Sts., San Francisco, other plants will be erected at various points in the state. Estimated cost to exceed $40,000 each. Private plans.

Pickle Factory—Frank Pickle Co., Berkeley, Calif., awarded contract for a 1 story, 150 x 300 ft. pickle factory on Berkeley St. to Austin Co. of California, 777 East Washington St. Los Angeles, Calif. Estimated cost $250,000.

Pipe Still — Shreveport Eldorado Pipe Line Co., Shreveport, La., awarded contract for the construction of a 750-100 bbl. pipe still, boiler house, tanks, etc. to M. W. Kellogg Co., 7 Dey St., New York. Estimated cost $175,000.

Plaster Factory—Victor Plaster Co., A. H. Dewey, Secy. and Treas., Powers Bldg., Rochester, N. Y., plans the construction of a plaster factory at Victor, N. Y. Estimated cost $75,000. S. Firestone, 59 South Ave., Rochester, N. Y., is engineer.

Porcelain Plant—Arrow Electric Co., 103 Hawthorne St., Hartford, Conn., will soon award contract for a 1 story, 40 x 40, 100 x 130, and 70 x 150 ft. factory, office and storehouse at Washington, N. J. Estimated cost $100,000. Mylchreest & Reynolds, 238 Palm St., Hartford, Conn., are architects and engineers.

Pottery Factory—W. S. George Pottery Co., East Palestine, O., will soon receive bids for a 1 story addition to pottery factory.

Pulp and Paper Mill—Hawley Pulp & Paper Co., W. P. Hawley, Oregon City, Ore., plans to rebuild pulp and paper mill. Estimated cost $3,000,000. Machinery and equipment including new central steam high pressure boilers, new engines, electric generators, etc. will be required.

Rayon Factory—Du Pont Rayon Co., 132 Madison Ave., New York, identified with E. I. du Pont de Nemours & Co., Wilmington, Del., is having plans prepared for the construction of a rayon factory 3,500,000 lbs. annual capacity at Ampthill, near Richmond, Va. Estimated cost $8,000,000 to $10,000,000. Work will be done under the supervision of Du Pont Engineering Co., Wilmington, Del.

Rayon Factory—Industrial Rayon Corp., 200 Madison Ave., New York, N. Y., will build a rayon factory at Covington, Va. Estimated cost, approximately, $10,000,000.

Rayon Factory — Viscose Co., Marcus Hook, Pa., plans the construction of a factory for the manufacture of rayon a textile yard at Vernon, Pa. Estimated cost $1,000,000. Ballinger Co., 12th and Chestnut Sts., Philadelphia, Pa., is architect.

Rayon and Silk Mill Addition—Jepson Art Weaving Co., Wadesboro, N. C., plans the construction of a mill for the manufacture of products made of silk and rayon including upholstery goods, tapestries, bed spreads, etc. Estimated cost $200,000.

Rayon Mill — Woonsocket Rayon Co., Woonsocket, R. I., awarded contract for a 4 story addition to rayon mill to W. McKillop Inc., Freeman St., Pawtucket, R. I. Private plans.

Refinery (Oil)—Indian Refining Co., 6707 Dix St., Detroit, Mich., is having plans prepared for the construction of an oil station including loading equipment, etc. Estimated cost $25,000. Private plans.

Refinery (Oil)—Lion Oil & Refining Co., Exchange Bank Bldg., El Dorado, Ark., will build a 1 story still house. Estimated cost $42,000. Work will be done by separate contracts.

Refinery (Oil and Gas) **and Cracking Plant**—H. A. Weir, and R. T. Pratt, representatives of Odessa Refining Co., Odessa, Tex. plan the construction of an oil and gas refinery and cracking plant. Estimated cost $200,000.

Rubber Factory—Firestone Tire & Rubber Co., South Main St., Akron, O., is having plans prepared for the construction of a rubber factory at Broad and Lombardy Sts., Richmond, Va. Estimated cost $250,000.

Rubber Factory—Owner, c/o Gibraltar Fire Corp., 511 47th St., Union City, N. J., plans to rebuild 1 story rubber factory recently destroyed by fire at West New York, N. J. Estimated cost $50,000. Architect not selected.

Rubber Factory—I. T. S. Rubber Co. of Canada, Ltd., 28 Alpine Ave., Toronto, Ont., plans the construction of a 3 story, 80 x 150 ft. addition to rubber factory. Estimated cost $150,000. B. Clayton, 28 Alpine Ave., Toronto, Ont., is architect.

Rubber Factory—Stetson Rubber Co., c/o Corona Cord Tire Co., Butler, Pa., will build three 1 story, 42 x 100 ft. factory buildings at East Butler, Pa. Estimated cost $75,000. Private plans.

Spark Plug Factory—A. C. Spark Plug Co., Flint, Mich., will soon award contract for a 3 story addition to factory for porcelain department on South Saginaw St. Estimated cost $40,000. Wright & Nice, 4339 South Saginaw St., Flint, Mich., are architects. Equipment will be required.

Tannery and Leather Products Plant—San Antonio Boot Co., S. L. Gill, 5500 South Presa St., Pratt, Tex., awarded contract for first unit of tannery and leather products plant, 1 story, 80 x 175 ft. to Walsh & Burney, 928 North Flores St., San Antonio. Estimated cost $100,000.

Winery—Grimsby Grape & Wine Co., J. A. Livingston, Mgr., Grimsby, Ont., plans the construction of a 1 story, 50 x 150 ft. winery on First St. Estimated cost $50,000. Complete equipment will be required.